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Compressed Air Magazine

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APRIL, 1926

CIRCULATION THIS ISSUE
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PORTABLE COMPRESSORS GO FAR AFIELD IN SOUTH AFRICA TO SERVE MINING PROPERTIES REMOTE FROM RAILROADS

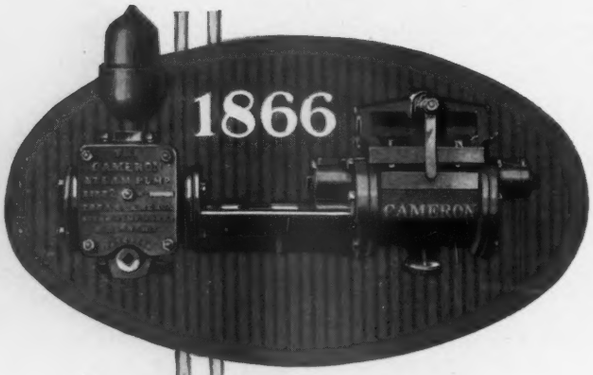
Putting Power of Georgia's Rivers to Work
J. E. O'Rourke

Compressed Air Helps in Harbor Building
F. A. Collins

Making Sanitary Ware On a Large Scale
H. H. Starkey

Water Works Save by Oil-Engine Drive
Kenneth Foster

(TABLE OF CONTENTS AND ADVERTISERS' INDEX, PAGE 5)



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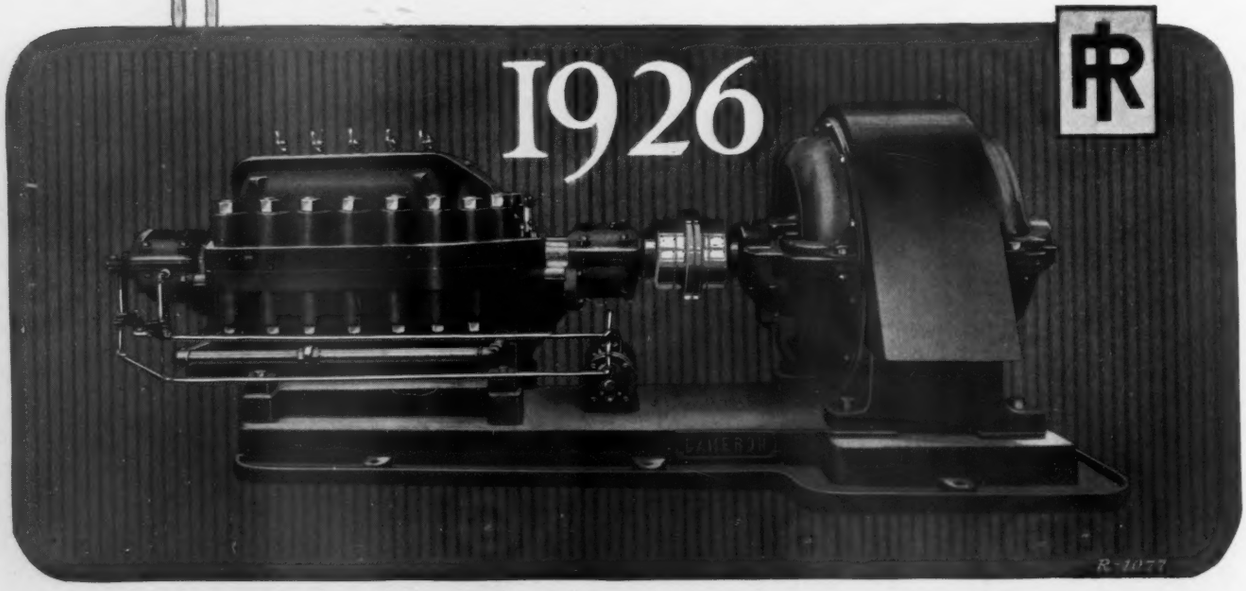


229-DV

Cameron Pumps

As a matter of reciprocal business courtesy help trace results

CONTENTS OF THIS ISSUE

Vol. XXXI, No. IV, April, 1926

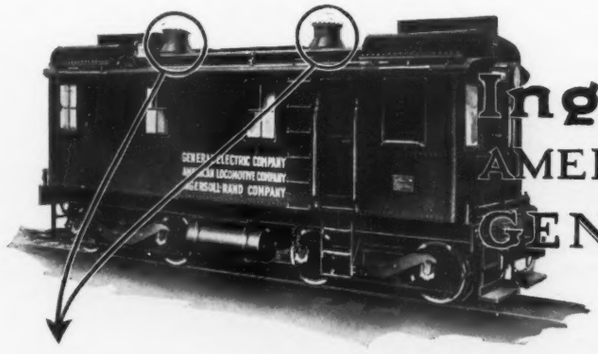
NOTE—For subscription terms see first Editorial page

Articles

Water Works Save by Oil-Engine Drive. *Kenneth Foster*..... 1577
Globular Gas Tank..... 1580
Discarded Grindstones Put to Further Use 1580
Saving Crumbling Walls of Durham Castle. *Denham Y. Marshall* 1581
New Sources of Potash in the United States 1582
Air Drills Help Relieve Housing Storage 1582
Torch Forms Gas Main on the Job 1582
Making Sanitary Ware on a Large Scale. *H. H. Starkey*..... 1583
Wind Data May Reduce Building Costs 1586
Furnaces for Hardening High-Speed Steels 1586
Moffat Tunnel Sure to be Holed Through on Time..... 1587
Air Hoist for Use with Portable Compressors 1588
Leather Belt with an Unusual Record 1588
Compressed Air Helps in Harbor Building. *F. A. Collins*..... 1589
Bed of Abandoned Railway Now a Motor Road 1592
Exploratory Deep-Hole Drilling. *K. K. Brown*..... 1593
Easily Made Air Filter for Stove Plant. *J. Russel Yocom*..... 1594
Wooden Building Gets New Lease of Life. *A. M. Hoffmann*..... 1595
Steel Tubes Driven with Air to Bedrock Support Skyscrapers... 1596
Putting Power of Georgia's Rivers to Work. *James E. O'Rourke*.. 1597
Great Britain's New Power Program 1602
One Cause of Decay in Stonework. 1602
Opening Up Coalfields in Kent.... 1602
Power-Driven Pump Devised by Ctesibios 1603
Editorial—Good Roads a Big Problem—Age of the Earth—Competition in Foreign Trade Grows Keener—Mystery of Cold Light Nearer Solution—Germans Would Build Cheaper Cars..... 1605
Book Reviews 1605
Notes of Industry..... 1606

Advertisements

Audel, Theo. Co..... 23
Bucyrus Company 10
Bury Compressor Co..... 20
Cameron Steam Pump Works, A. S. 2
Caterpillar Tractor Co..... 9
Combustion Engineering Corp..... 15
Continental Motors Corporation... 3
Erie Steam Shovel Co..... 22
France Packing Co..... 21
General Electric Co..... 8
B. F. Goodrich..... 13
Goodyear Tire & Rubber Co..... 4
Hercules Powder Co..... 17
Ingersoll-Rand Co..... 6-7-25
Jarecki Mfg. Co..... 21
Jenkins Bros..... 22
Jewett 22
Edw. R. Ladew Co., Inc..... 21
Lidgerwood Mfg. Co..... 20
Longstreet, Lawrence C..... 22
Manzel Bros. Co..... 23
Maxim Silencer Co..... 5
Midwest Air Filter Co.....Back Cover
New Jersey Meter Co..... 23
Staynew Filter Corp..... 24
Stearns Rodgers Mfg. Co..... 20
Swartwout Company 21
Terry Steam Turbine Co..... 11
Vacuum Oil Co..... 14
Waukesha Motor Co..... 19
Western Wheeled Scraper Co..... 12



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Compressed Air Magazine

NEW-YORK LONDON PARIS

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Water Works Save By Oil-Engine Drive

A New Jersey Borough Cuts Pumping Costs Nearly Three-Fourths

By KENNETH FOSTER

HOW to make sure of an adequate supply of pure water is a matter of concern to many communities. This is all the more serious when the water is for both domestic and industrial uses.

The accompanying article has to do with a borough in New Jersey having a population of 11,000 persons and forming the center of a number of large plants in which water plays an important part in manufacturing or industrial activities.

The problem of a sufficiency of water at all times and at the lowest practicable pumping cost has, in the case of Lodi, N. J., been successfully solved by the adoption of oil-engine drive. The savings are notable and significant.

LODI is a borough, in the eastern part of New Jersey, having a population of about 11,000 persons. It is situated on the banks of the Saddle River, and is the home of several large industries. Although small in size, Lodi has some very progressive ideas, one of which is the borough ownership of the water-supply system.

The old water-supply system consisted of three separate pumping stations situated a considerable distance apart. Pump Station No. 1 contained a deep-well pump operated by engines using city illuminating gas. The cost of gas alone for these engines averaged about $37.68 per 1,000,000 gallons of water pumped. For continuous operation this station required the services of an attendant for each 8-hour shift. In Pump Station No. 2 there was a well pumped by a direct-acting steam pump. This station also required the services of an attendant for each 8-hour shift. The cost of coal for pumping purposes only averaged about $56.38 per 1,000,000 gallons. Pump Station No. 3 housed a deep-well centrifugal pump driven by an electric motor. This station did not have the continuous services of an attendant, which was a somewhat dangerous practice. Electricity, on power schedule, cost about $71.15 per 1,000,000 gallons of water pumped.

All these pumps drew water from individual Artesian wells, and the supply varied from a minimum of 360 gallons per minute to a maximum of about 465 gallons per minute. At times the demand exceeded these amounts and additional water had to be secured from the water-supply systems of adjoining towns. In none of these stations, as arranged, was it practicable to have duplicate pumping units to provide against breakdown.

Whenever a breakdown occurred, that particular unit and its quota of water were not available for the use of the town until repairs had been completed. Such breakdowns happened occasionally. Some of them required only a few hours for repairs while others called for as much as five weeks to get the unit back into running order. The idea foremost in mind in designing the new water works was reliability of service, combined with economy and ease of operation.

Pump Station No. 2 was selected as the most desirable location for the power plant for the new water-supply system. Five new wells were drilled near this station, thus providing for future needs inasmuch as the demand for water increases yearly. These five wells, together with the older wells tributary to the station, showed, on a long-time test, a combined supplying capacity of about 1,400 gallons per minute.

The power plant consists of two similar units. The prime mover of each of these units is a 110-H.P. Ingersoll-Rand PO oil engine, which is connected by a flexible coupling to an I-R air compressor and by a short belt drive to a double-suction, single-stage Cameron centrifugal pump. The water is raised from the wells by air lifts and flows by gravity into a sump pit in the pump station. From there the water is drawn by the centrifugal pumps and sent out through the distributing mains to the reservoir.

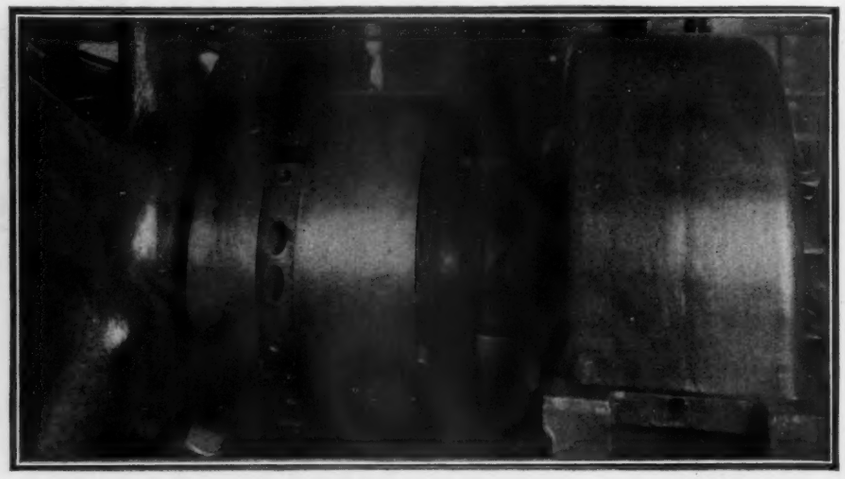
The piping from the starting units to the oil engines has been so arranged that either oil engine can be started from one or the other of the starting units or from both of them at the same time. Furthermore, the piping has been so laid out that a third oil-engine pumping unit and a third starting unit can be added to the plant in the future without disturbing the present piping or without interfering with the flexibility of the existing system.

The air compressors and the air receivers of the pumping units have been connected by means of a system of valves that permits any compressor or combination of compressors to discharge into any receiver or combination of receivers. The valves and the pipes are so arranged that a third compressor and receiver may be added without changing either pipes or valves and yet maintain the aforementioned flexibility. This arrangement permits the operators to inspect or repair any receiver without stopping the compressor or without diminishing the amount of air supplied to the wells.

The outlets of the receivers are connected by a manifold system so that any well system or combination of well systems may be

run by any receiver or combination of receivers. This is invaluable in case a certain system of wells requires a high starting pressure. Then that particular system may be started by raising the pressure in one compressor while the wells under low pressure are running on the other compressor. The valves are all manipulated at the pumping station.

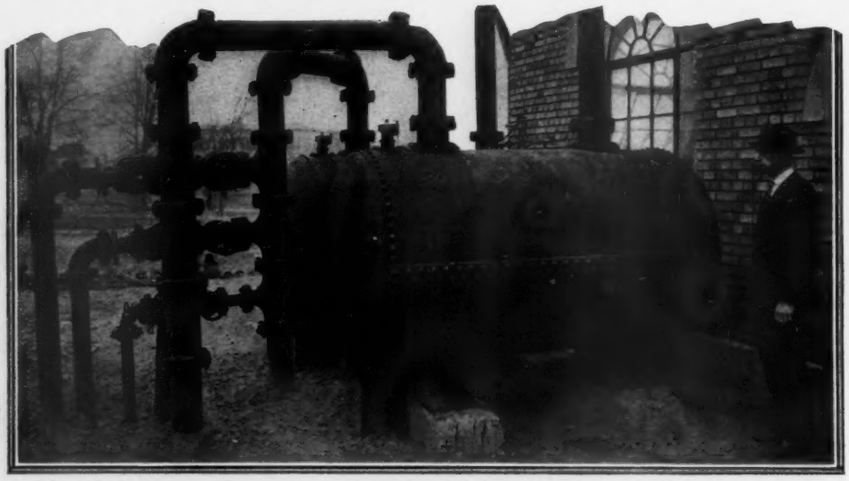
Under normal operating conditions the centrifugal pumps run single stage and deliver 660 gallons per minute at a pressure of 75 pounds. A simple crossover has been arranged so that in case of fire two single-stage pumps may be operated as a single 2-stage and deliver 850 gallons per minute at 100 pounds pressure. At present, one unit is sufficient to pump the quantity of water required by the town, and the second unit serves as a standby to be used in case of emergency or while repairs are being made on the other unit.



Each oil engine is connected with its associate compressor by means of an I-R adjustable, flexible coupling.

The plans have been drawn so that in future, when it is necessary to operate two units to supply the needs of the borough, a third unit and even a fourth unit may be installed. These units may be added later with only slight additions to the present piping and yet permit the present flexibility to be maintained. The borough is now practically 100 per cent. metered, thus accounting for a low per capita consumption of water.

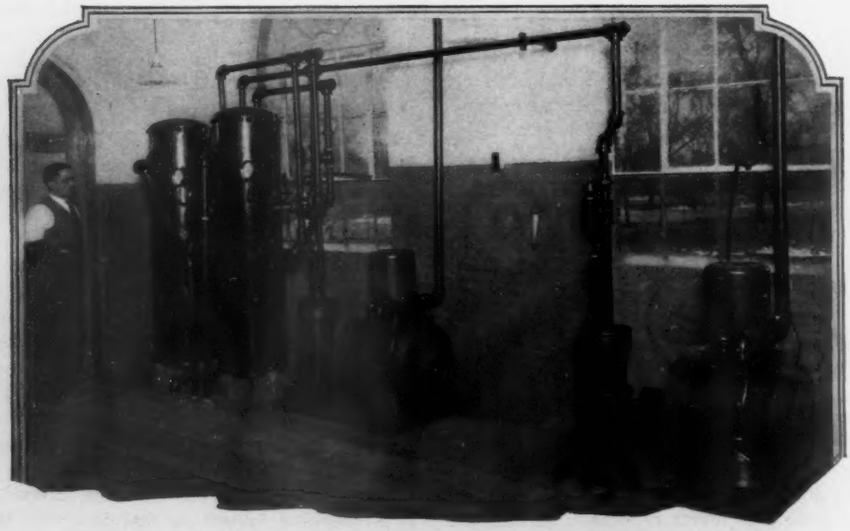
Each of the new units, if run continuously, is capable of pumping about 28,000,000 gallons of water per month while all the old units, when operated continuously were capable of furnishing only from 15,000,000 to 20,000,000 gallons per month. It is estimated that the saving from operating the new plant will amount to from $10,000 to $15,000 a year, computed on the basis of the average consumption during the past six months. As the consumption increases the total saving will, of course, become greater.



Air receivers, just outside the pumping station, with their connections to the air lifts by which water is pumped from the different wells.

The cost of fuel oil at present prices runs from $11.50 to $12.25 per 1,000,000 gallons of water pumped. By comparing the following tables, showing the principal items of expense, it can be readily seen what the factors are upon which the annual saving is estimated.

During one month recently the consumption of water in the Borough of Lodi rose to 19,000,000 gallons—that is, substantially 6,000,000 gallons more than the prevailing average consumption. Had the old pumping plant



Air receivers and two small compressors which provide starting air for the large oil-engine units.

OLD PLANT

3 men at $1,900 each per year	$ 475.00
3 men at $5.40 each per day	486.00
Coal at $12 per day	360.00
Electricity	292.00
Gas	267.00
Miscellaneous supplies	20.00
Cost of pumping an average of 13,000,000 gallons per month	$1,900.00

NEW PLANT

Fuel oil	$ 156.75
3 men at $1,900 each per year	475.00
Miscellaneous supplies	15.00
Cost of pumping an average of 13,000,000 gallons per month	$646.75

Fig. 1—Water is delivered to the borough mains by these two double-suction, single-stage Cameron centrifugal pumps which are driven from the oil engines by short belts. One pump is capable of taking care of the present demand.
Fig. 2—Water flows by gravity from the air lifts at the wells into an open sump pit in the pumping station.
Fig. 3—Air for operating the air lifts is furnished by two compressors each of which is driven by a 110-H.P. Ingersoll-Rand oil engine.
Fig. 4—The two units in the station viewed from the sump-pit side of the engine-room.
Fig. 5—Pumping station with air receivers on the north side. Immediately under the eave on the east side are located the screens through which all air is filtered before going to the compressors.

Mayor and council of the Borough of Lodi, N. J. At right, consulting engineer for the borough.

OPERATING COSTS LODI WATER WORKS

OLD PLANT			NEW PLANT	
Monthly Consumption Gallons	Total Monthly Cost	Cost per 1,000,000 Gallons	Total Monthly Cost	Cost per 1,000,000 Gallons
13,000,000	$1,900.00	$146.15	$ 646.75	$49.75
19,000,000	2,792.00	146.95	724.10	38.11
28.000,000	3,990.00	142.50	837.65	29.92
56,000 000	7,725.00	137.94	1,185.33	21.17

been in service it would have been impossible to meet the increased demand, and the additional 6,000,000 gallons required would have been furnished by the water works of an adjoining town and at an approximate cost of $892. In other words, with the old plant and such a situation, the water for the month in question would have cost the borough a total of $2,792. On the other hand, with the new system in operation, the actual added cost for the extra 6,000,000 gallons amounted to only $77.35—this figure representing the proportionate increase in consumption of fuel oil, together with an increase of $5 for miscellaneous supplies. That is to say, the cost of pumping 19,000,000 gallons of water for the month mentioned amounted to $724.10.

The Lodi pumping plant was designed and installed by Wolcott C. Foster, consulting engineer, Rutherford, N. J.; and during the first six months of its service the operation of the new plant was supervised by this expert.

It is interesting to note that 51 railroads in the United States and in Canada are now using motor trucks for the carriage of freight. While 43 of the roads confine the service of these trucks to terminal movement, 8 of the lines are employing them in place of local freight trains.

The Great Lakes, with a shore line of about 4,000 miles on the United States side alone, contain one-third of all the fresh water in the world.

GLOBULAR GAS TANK

A NOVEL container for storing gas was recently built for the Central Arizona Light & Power Company at Phoenix, Ariz. Instead of the customary tank, a huge steel sphere was erected. Aside from its uniqueness, this type of tank—known as the "Hortonsphere"—is said to be an improvement in certain directions over the familiar cylindrical gas holder.

A spherical tank has a larger capacity, in proportion to the amount of material in its getup, than a tank of any other design and calls for less ground space for its foundation. In addition, the plates in a sphere are not subjected to the strain to which those in a cylindrical tank are subjected. The reason for this can be made quite plain.

This spherical gas tank, at Phoenix, Ariz., has a capacity of 300,000 cubic feet when containing gas at a pressure of 50 pounds to the square inch.

We know that a soap bubble, or a toy balloon, assumes a spherical shape when air is blown into it because the pressure exerted against the inner surface is equal in all directions. Naturally, this applies with equal force to the "Hortonsphere." In the case of a cylindrical container, however, the strain on the longitudinal seams is twice as great as that on the circumferential seams.

The tank at Phoenix has a capacity of 300,000 cubic feet with gas at a pressure of 50 pounds to the square inch. Although this is the normal working pressure, the holder has been built to withstand a pressure of 200 pounds to the square inch. The steel plates used in its construction are ¾ inch thick and are held together by butt straps with 1⅛-inch rivets 3 inches long. A total of 29,000 rivets were required for this work. The tank, which weighs 480,000 pounds, was built at a cost of $60,000.

DISCARDED GRINDSTONES PUT TO FURTHER USE

WE can trace the "beating of swords into ploughshares" back to biblical times, but the transforming of discarded grindstones into walls, roads, and even churches, is something very new, indeed.

In grinding the innumerable saws and other tools at the vast plant of Henry Disston & Sons, Inc., of Philadelphia, Pa., a great many of the grindstones employed for the purpose are soon worn down to such an extent that they are no longer fit for their work. Until a short time ago, the factory yard was the repository for these discarded stones. Then, an imaginative person at the plant conceived the idea of squaring them and thus turning them into an excellent building material.

The idea was promptly carried out. Some of the squared grindstones now form a wall around two sides of the property, while others have been used in the building of roads in and about the plant, which covers an area of 65 acres. In addition, there was erected a retaining wall along the Delaware River side; but for this job the grinders were employed without reshaping.

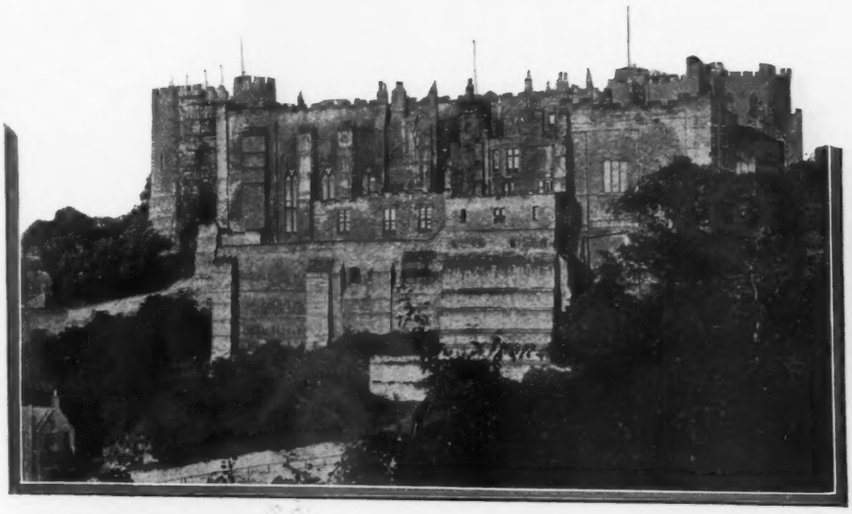
But the most noteworthy use to which the grindstones were put was in the erection of the Tacony Baptist Church, situated near the factory site. For this work over 2,500 stones were needed; and these were cut and dressed so carefully that it would never occur to anyone that the pleasing structure was built of discarded grindstones or, in other words, waste material.

According to press reports from England, a new glass has been invented in Austria that has none of the familiar characteristics of glass except its transparency. It bends in any direction, breaks without splintering, and, when in spherical form, bounds like a rubber ball. The question that naturally arises in one's mind is, "Is this glass really glass?"

Saving Crumbling Walls of Durham Castle

By DENHAM Y. MARSHALL

DURHAM Castle, situated upon a hill overlooking the City of Durham, England, is perhaps one of the finest examples of those fortifications that were built by the Church for the defense of its congregations against invasion by the Scottish Kings, and also to uphold the power of the Church against the authority of the ruling sovereign of England.



Durham Castle from the west. The massive masonry of this part of the structure was found to be seriously weakened and, if not strengthened, likely to slide into the river below.

Not long ago, it was found that there was danger of the whole of that part of the castle which overlooks the River Weir sliding down into the river 200 feet below. Work was at once begun to save the wonderful old buildings, some of which were reared as far back as 1071. Even the more recent additions to this ecclesiastical stronghold are at least 500 years old.

In this work of restoration—which it is hoped will preserve Durham Castle for future generations—compressed air, figuratively speaking, is now playing as big a part in the defense of the old walls and foundations against disintegration as the soldiers in 1075 played in the defense of the stronghold against the armies of the Danes.

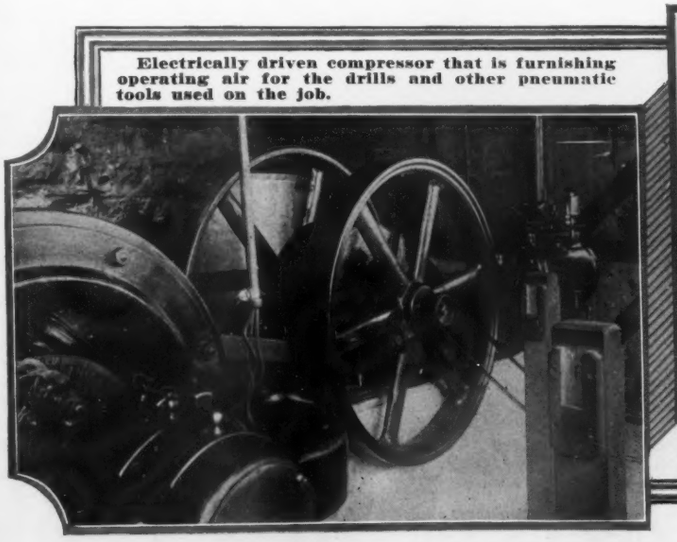
The method employed to accomplish this task of rehabilitation may perhaps be gathered from the following description. By means of a number of small "Jackhamers," holes are being drilled down through the foundation walls and buttresses until solid rock is reached—the drilling then being continued for an additional 2 or 3 feet. In some cases it has been found necessary to drill to a depth of over 20 feet before reaching the rock. Into each of these holes is placed a bar of ¾-inch square "Delta" metal. This is a patent non-corrosive metal which has the appearance of brass or bronze. The bar is cut about 6 inches shorter than the hole into which it is to be placed; and its two ends, for a distance of about a foot, are twisted so as to assure a firm bond between the foundation and the rock when the hole has been filled with a liquid grout of cement and sand.

Cementation under pressure is employed—the "gun" on the job simply consisting of a cylindrical tank with a capacity of about 30 gallons. In the top of the tank is a connection for a compressed-air line as well as a charging hole covered by a screw cap. At one end, near the bottom, is a connection for the cement hogger, and at the other end there is a handle. By turning this handle it is possible to keep the cement agitated during the "shooting."

Into the walls and the buttresses of the castle, horizontal holes are being drilled and similarly filled with grout. However, in the case of these holes, it is not necessary to use the metal bars except where added strength is desired. In places, the walls are extremely thick. Already many thousands of feet of holes have been drilled into them, and there is still much work of this kind to be done. Into some of the drill holes has been forced as much as 1,000 gallons of grout owing to the big cavities which have formed in the walls where the stonework has crumbled away.

Pneumatic chipping tools, etc., are being used to redress some of the exterior stonework and also to chip away mortar wherever stones have to be removed for the purpose of making repairs. Again, in raising and lowering scaffolding and stones, and in lifting the materials required by the cement machine, a "Little Tugger" hoist is playing a very important part. In other words, the hoist has saved both the contractor and his men much time and labor.

In the castle courtyard and near the entrance to the great hall, through which at least a dozen kings of England have passed, there has been set up a belt-driven Class "ER" compressor, and this unit supplies all the air re-



Electrically driven compressor that is furnishing operating air for the drills and other pneumatic tools used on the job.

Air-driven "Jackhamers" drilling holes in the masonry of one of the great buttresses in order to penetrate to the weakened core.

This form of air-operated concrete "gun" is used to force grout into the disintegrated interior of the masonry walls and foundations.

quired in placing the grouting and in operating the pneumatic tools and the hoist.

Similar work has been carried out successfully on Lincoln Cathedral and has just been started on St. Paul's Cathedral, in London, which has become unsafe in the centuries that have passed since it was built. It is gratifying to think that compressed air may prove to be a means towards preserving these famous monuments for the enjoyment and the edification of future generations.

NEW SOURCES OF POTASH IN THE UNITED STATES

WE may yet be independent of foreign supplies of essential potash if deposits discovered within our own boundaries prove as extensive as certain exploratory work would seem to indicate. Such, in short, is the inference to be drawn from a report lately issued by the United States Geological Survey concerning potash deposits that have been found in Texas and in New Mexico.

Since August, 1924, when the German and the French potash producers signed an agreement concerning sales of their potash in the United States, the price of potash in this country has been controlled by this re-established foreign monopoly, which directly or indirectly supplies 90 per cent. or more of all potash used by us. Potash is required in large quantities in growing such crops as cotton, tobacco, potatoes, and garden truck, and is used in certain chemical industries—some of which are vital to the national defense. It is, therefore, necessary to the public welfare that we discover all possible American sources of potash so as to be able to check the domination of foreign producers and to prevent a recurrence of the very high prices that prevailed during the World War.

It seems that some of the salt beds of western Texas and southeastern New Mexico give promise of yielding great quantities of potash. These beds have been penetrated by the tools used in exploring for oil. The cumulative evidence of this exploratory work suggests the probability of extensive potash-bearing strata several feet thick.

AIR DRILLS HELP RELIEVE HOUSING SHORTAGE

VIENNA, like many other large cities, has been confronted with a housing shortage, due in the main to the suspension of building operations during the period of the World War. Latterly, the municipality of Vienna has undertaken to relieve the acute situation by constructing numerous large buildings subdivided into small flats or apartments.

For reasons of economy, the interior partitioning walls have been made in a great many cases by using slabs or panels formed of plaster of Paris. The employment of this material has brought in its train certain difficulties, especially when the builders were called upon to cut rills or channels in those partitioning walls for the purpose of running electric wires for lighting, etc. The problem was to cut the channels without needlessly fracturing or breaking away excessive amounts of the plaster. A hand-driven chisel was too shattering in its effect, and means had to be found to do the cutting with the least practical concussion.

Air-driven drill fitted with a special cutter for forming rills or channels in which to place electric wiring in Vienna buildings.

Finally, after considerable experimenting, the technical department of the city government found that the work could be done satisfactorily and quickly by utilizing pneumatic drills equipped with special cutters. To be specific, what are known as No. 600 I-R drills were found admirably suited; and the authorities thereafter adopted this tool and this procedure as a standard.

TORCH FORMS GAS MAIN ON THE JOB

THE following account is interesting because it shows how a large gas main can be assembled at a point remote from the mill that furnishes the plates that are to be welded together to form the pipe sections. The facts, in a much condensed form, are from *Oxy-Acetylene Tips.*

A gas company at Portland, Ore., recently completed the making and the laying of 3 miles of 30-inch and 4 miles of 24-inch steel piping. This piping was carried across the continent in the form of flat sheets, $^5/_{16}$ inch thick and 12 feet long, and was rolled and welded at the point of use by the oxy-acetylene process. Each sheet was first welded longitudinally, and then three of these units were welded together.

With this done, the 36-foot lengths were tested at a hydrostatic pressure of 150 pounds and then with air at a pressure of 50 pounds—soapy water being painted over the welds, and the few pinhole leaks being closed by calking. After the pressure test, the sections were passed successively through a series of dipping tanks containing, respectively, a hot alkali solution to remove the grease; a hot dilute sulphuric acid to clean off scale; an alkaline neutralizing bath; and a hot-water rinse. Drying by means of gas flames, played on the inside of the pipe sections, completed the preliminary treatment.

Before welding the units together, each pipe length was capped at both ends, dipped in asphaltum, and rolled in grit—the caps serving to prevent the asphaltum from getting inside and also to keep the ends free from grit, etc., to facilitate welding. Three 36-foot lengths were placed upon trestles and welded before lowering into the trench. The longitudinal seams were alternately offset 14 inches from one another and were all on top within easy reach.

We have roughly computed the number and the aggregate length of the welds in this job, and find in the 7 miles of pipe line over 3,000 separate longitudinal welds and a corresponding number of circular welds. The total length of all the welds is 11 miles—7 miles of longitudinal welds and about 4 miles of circular welds. The time required from the beginning of operations in the shop until the line was completed and in the trench was less than 6 months.

Making Sanitary Ware On a Large Scale

Pneumatic Spraying of Fuel Oil Permits Very Nice Regulation of Kiln Temperatures

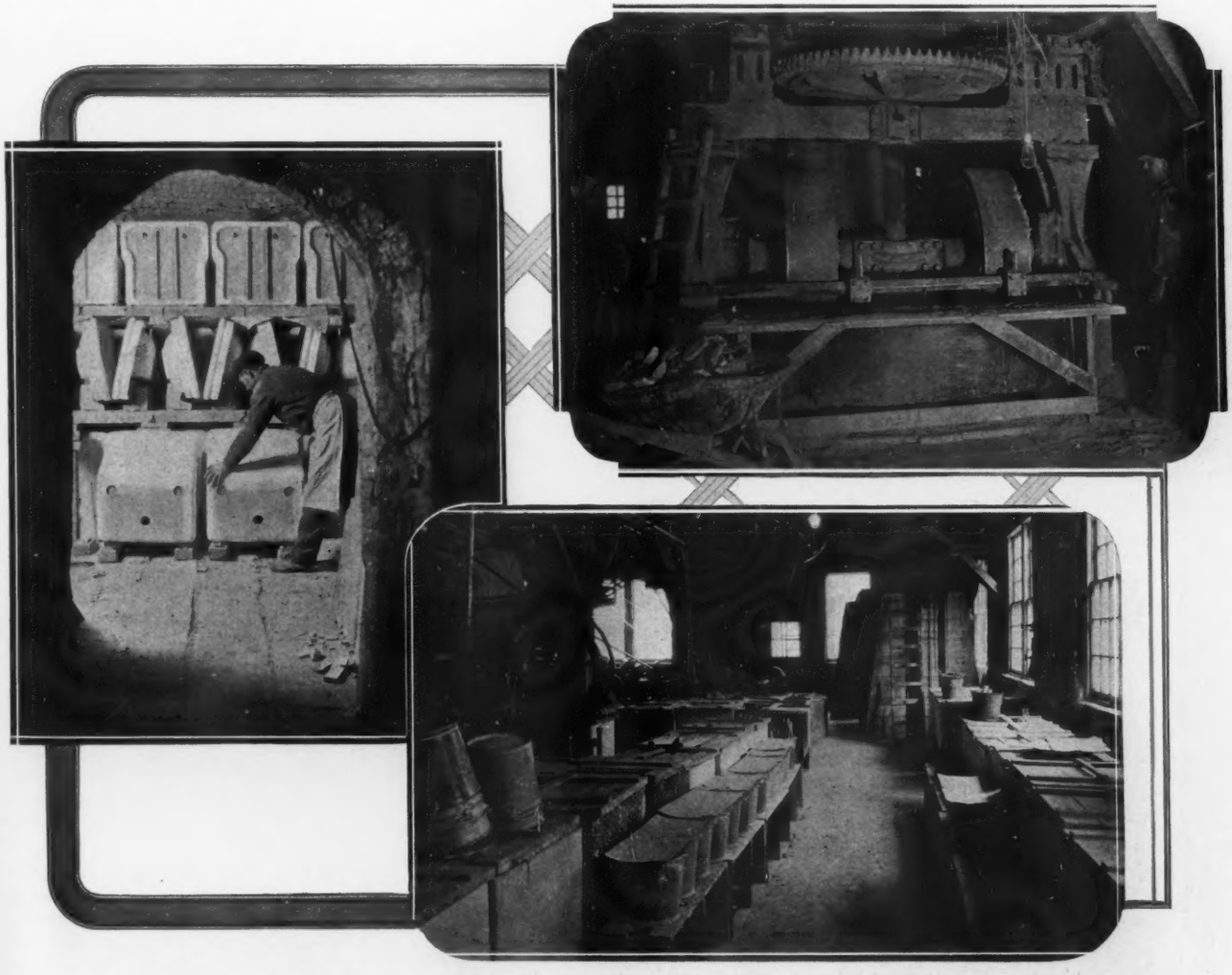
By H. H. STARKEY

WHEN the mind of prehistoric man began to grope for artistic expression, it was discovered that certain kinds of earth on which he trod could be molded, after the addition of water, into many shapes; and, when set out in the sun to dry, the molded pieces attained a hardness that was not characteristic of the original clay. Later, crude kilns were made in which the clay was hardened to a much greater degree by heat from a wood fire. From this obscure beginning has evolved one of the world's greatest industries—the manufacture of porcelain ware.

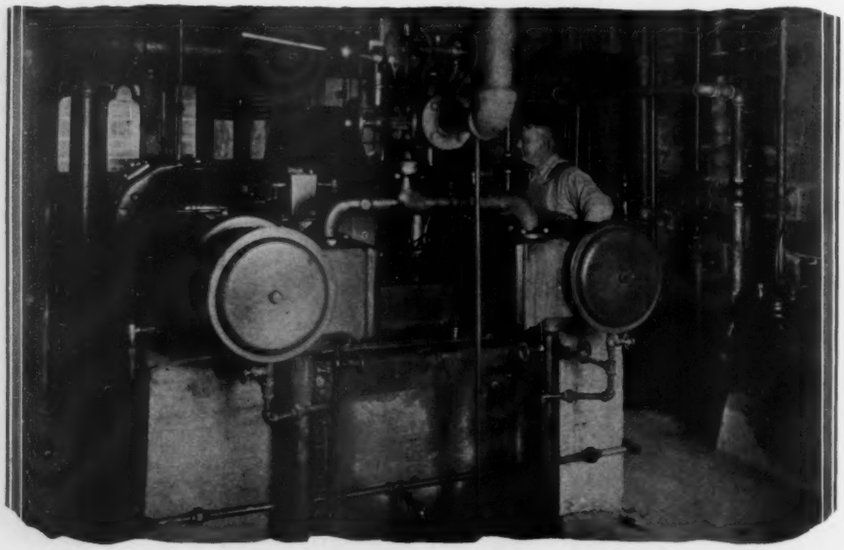
In the United States, where the tendency is to specialize in the production of manufactured articles, we find that the porcelain industry is no exception to the general rule. And so it is not surprising to learn that one branch of the ceramic art produces only what is known as sanitary plumbing ware.

In the cosmopolitan city of Perth Amboy, N. J., is situated what is said to be the largest plant in the world devoted to the making of porcelain plumbing specialities. It is the Fords Porcelain Works, Inc. The growth of this plant to the enviable position it holds today is the story of the efforts of a single man—Mr. Abel Hansen. Twenty years ago, in the little town of Fords, lying a short distance from Perth Amboy, Mr. Hansen commenced manufacturing porcelain ware. Twenty people were employed by him in a small 1-story building measuring 70x100 feet. Today, the plant at Fords covers 416,000 square feet; and, in addition, there is a group of structures at Perth Amboy having a total floor space of 680,000 square feet. In summer, when the peak of production is reached, 500 workmen are needed to carry on the work. Indeed, this remarkable expansion led Mr. Hansen to turn the business into a corporation, all the officers of which are members of his immediate family.

The Fords Porcelain Works is up to date in every respect. Steam-driven machines make possible the production of the earthenware in great quantities. Electric cars and conveyers assure the speedy transportation of material to and from the several departments. In short, when one considers the following few random facts, namely, that 40 tons of clay are used daily; that over $200,000 worth of porcelain



Left—Piling products in a kiln preparatory to subjecting them to a temperature of 2,400°F. for 48 hours. Right—One of the "grog pans" in which dry clay is ground fine between two ponderous wheels. Bottom—Section of plant where liquid clay is prepared for casting.



Steam-driven I-R compressor that furnishes air for atomizing fuel oil in 21 kilns.

ware is manufactured every month; that 31 oil-fired kilns at the plants at Perth Amboy and Fords are utilized 24 hours a day; and that more than 2,000,000 gallons of fuel oil are consumed yearly in furnishing heat for these kilns, it becomes evident that the business has taken on proportions which would be unbelievable to artisans of other days.

In order to realize how quantity production is made possible, let us follow the clay from the time it enters the works until it comes out of the kilns in the finished form of the potter's art.

The basic clay used at the Fords Porcelain Works is procured from deposits within 50 miles of Perth Amboy. Inasmuch as a great amount of the material is shipped to the plant by rail, the storage bins—28 in all—have been conveniently placed alongside the main building and within easy reach of the track to facilitate dumping. About three months' supply is generally kept on hand in order to take care of any sudden demand for increased production. But before the clay can be put through the several processes, that is, to make it fit for molding, it must be thoroughly dried. To do this, waste heat from the kilns is forced by an electric fan through pipe lines to each bin.

The initial step in the manufacture of the ware is grinding. Workmen transport the raw material from the bins to an electric conveyer, which dumps the clay into a "grog pan"—a huge machine measuring 10 feet in diameter. This machine consists of a movable steel disk or base made up of four sections, called "Mueller plates." Near the rim of this disk are numerous perforations. Two steel wheels—each weighing 18,000 pounds, having a diameter of about 5 feet and a tread of 16 inches—bear on the Mueller plates. A broad belt, driven by steam power, sets in motion a series of gears that revolve the disk which, in its turn, revolves the grinding wheels in contact with it. The centrifugal force so induced causes the clay to move outward toward the rim of the disk, where the material is crushed under the wheel treads and pressed downward through the perforations. The pulverized clay is then passed over an electrically operated screen having a No. 14 mesh. All the granules that are too large to sift through this mesh are returned to the grog pan for regrinding.

After screening, the clay is carried by another electric conveyer to a mixing machine. In transit to the mixer, the clay is passed over an electro-magnet for the purpose of removing from it any iron or steel particles. The mixer is a long, horizontal drum, through the center of which runs a belt-driven shaft having 30 propeller-like blades. As the dry clay drops into the mixer at one end, water is added—the revolving blades kneading the moistened clay and carrying it forward until it is discharged at the opposite end of the machine, where it issues in dough-like lumps. These lumps are stacked for 10 days, and during this period the clay undergoes what is known as aging.

After aging the clay is again put through the mixer for tempering. The plastic lumps are taken by the workmen to a "pug mill," a machine that removes by pressure all air pockets and laminations. The clay turned out of the pug mill is uniformly shaped, each slab measuring 4 inches thick, 10 inches wide, and 12 inches long.

The clay is now ready to be molded into bath tubs, sinks, and other products familiarly known as sanitary ware. Small electric trucks carry the plastic blocks to the pressing room, where skilled men model the material by packing or pressing it into molds consisting of 2 or more parts. After 2 or 3 hours the molds are carefully removed, and the clay forms are smoothed down with steel polishing knives. In the course of 3 days the clay becomes "leather-hard" and is then ready to receive a white vitreous coating, which is applied to the surface with a brush. Among the ingredients of this "lining," as the coating is called, are English china clay, English ball clay, American flint, and feldspar. After being so surfaced, the articles are shifted to another part of the pressing room directly under a number of steam-heated pipes, which thoroughly dry the clay in 12 to 14 days. A white enamel glaze is then applied.

Another method of manufacturing vitreous ware has recently been developed at the Fords plant. In this process such materials as feldspar, and china and ball clay are dumped into a "pebble mill"—a large, horizontal steel drum, 8 feet long and 6 feet in diameter—containing a quantity of loose pebbles. Water is added to the clay, and the belt-driven drum is set in motion.

After grinding in the pebble mill for 6 hours the plastic material is poured into an agitator—a large, round receptacle—where the "slip," as the clay is now called, is kept continually in motion to prevent hardening. The slip is pumped through a pipe line to the casting room, and poured into as many of the several hundred molds as needed. In 2 hours the clay hardens, whereupon the cores of the molds are taken out and the newly shaped porcelain ware is placed on a drying rack. The glazing is

One of the pressing rooms in which various forms of sanitary ware are modeled.

MAKING SANITARY WARE HAS MANY INTERESTING ANGLES

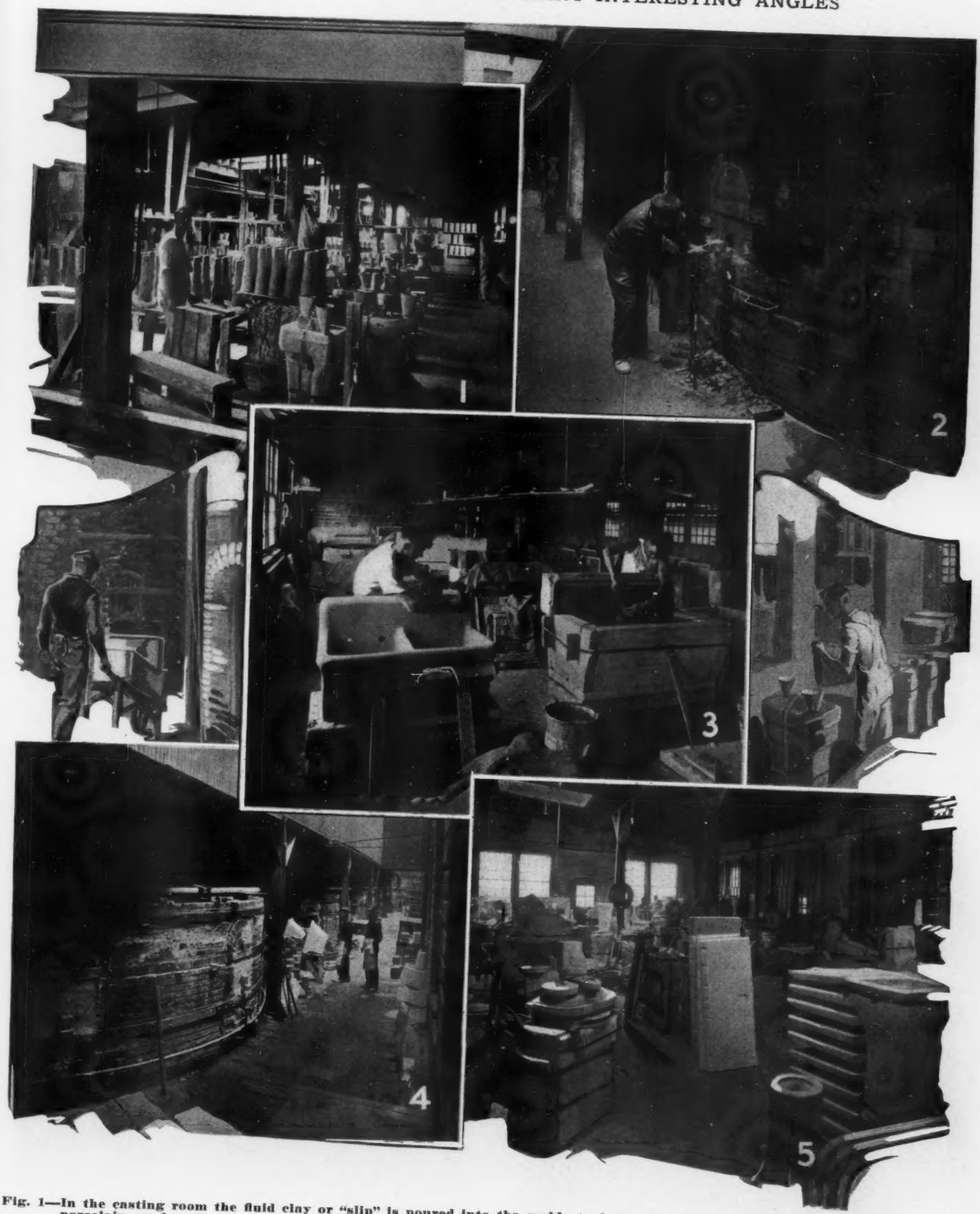


Fig. 1—In the casting room the fluid clay or "slip" is poured into the molds to form the different commodities produced in the porcelain works.

Fig. 2—Fuel oil, atomized by compressed air, is burned in the kilns to insure a carefully sustained temperature of 2,500°F. for a continuous period of 120 hours.

Fig. 3—In this room the workers are smoothing down the surfaces of newly pressed clay products.

Fig. 4—Some of the 21 kilns in the Perth Amboy plant of the Fords Porcelain Works, Inc.

Fig. 5—Another section of the pressing room which gives an idea of the diversity of the wares turned out in the plant.

Sanitary ware crated and ready for shipping.

then applied in the same manner as in the pressing room.

We have now reached the last and the most important part of the process through which the clay must pass before it becomes a finished piece of sanitary ware—that is, the burning of the ware in the kiln. All the 21 kilns of the Fords Porcelain Works at Perth Amboy are of the down-draft, muffle type, and are shaped somewhat like Esquimaux huts. There are 14 oil burners in each kiln. Preheated oil is delivered to the burners at a pressure of 15 pounds to the square inch and atomized in the burner by air, at a pressure of 30 pounds, supplied by a steam-driven compressor.

The molded clay products are placed in the kiln, the doors are bricked up, and the fires started. For 120 hours the articles are baked at a temperature of 2,500° F. Each kiln is equipped with a pyrometer, which registers the degree of heat, and a CO_2 recorder, which records the efficiency of combustion.

The secret of producing fine earthenware depends largely on a carefully sustained, high temperature in the kiln. Any fluctuation in the oil pressure due to a faulty pump, or a drop in air pressure might cause a great monetary loss in material and in wasted labor. It is interesting to note that the compressor has been on the job continuously, throughout the 24 hours of the day, ever since it was put in service 16 months ago.

The finished products taken out of the kilns are a delight to the eye in their glossy whiteness. Among the articles manufactured are: laundry trays, pantry and kitchen sinks, bath tubs, lavatories, shower receptors, drinking fountains, etc., as well as various associate fittings. An idea of the volume of the output at the Fords Porcelain Works may be gleaned from a recent production report which states that 700 porcelain sinks, 700 pedestal lavatories, 1,400 single trays, and numerous specially ordered plumbing accessories were turned out in the course of a month. It is significant that compressed air is a contributing factor in maintaining both the high quality of the ware as well as the quantity production of this large plant.

WIND DATA MAY REDUCE BUILDING COSTS

THE average pressure on a tall building when the wind is blowing at a rate of 76 miles per hour, which is equivalent to 100 miles per hour indicated speed, is about 22 pounds per square foot. In designing a structure, architects have commonly figured on a pressure of 30 pounds to the square foot, which actually corresponds to a gale blowing at the rate of 88.5 miles—118 miles indicated speed—per hour. In but a few cities in the Union, such as New York, St. Paul, and Chicago, have gales of this velocity been recorded.

Accurate data on the subject of wind pressures on tall buildings will prove of great value in designing skyscrapers, bridges, chimneys, transmission lines, radio masts, etc. Heretofore, in making allowances for the stresses produced by the pressure of high winds, values were used that were known to be too high—the values being based on experiments made a great many years ago. As a result, structures were made stronger than necessary.

To give the architect definite figures to work with, the United States Bureau of Standards has carried on a series of experiments, described previously in this Magazine, which have made it possible to determine the actual pressure corresponding to a given wind velocity. With this knowledge available, designers will now be able in many instances to prescribe the use of lighter building materials and yet retain a sufficient margin of safety. The only thing that remains to be done is to decide in each case the maximum wind velocity to be taken into account when planning a structure. Obviously, a higher rate of speed must be taken into consideration in designing a building that is to face the New York waterfront than one that is to stand in a sheltered section of Washington.

Largest of the five plants operated by the Fords Porcelain Works, Inc., at Perth Amboy, N. J.

FURNACES FOR HARDENING HIGH-SPEED STEELS

SINCE the discovery some 20 years ago of the benefits derived by subjecting certain chromium-tungsten or so-called high-speed steels to exceedingly high temperatures in hardening, there has been much discussion anent the best procedure and equipment for this heat treatment. There are still those who advocate hardening from a forge fire, and who claim superior performances for tools so treated in comparison with tools hardened from gas, oil-fired, or electric furnaces.

Some roughing-lathe tool tests were recently made at the United States Bureau of Standards to determine whether or not such claims were justified. It was found that comparable performances were obtained when tools were raised to approximately equal temperatures for equal lengths of time in hardening. As to the forge-fire method of treatment, no evidence was found of a mysteriously beneficial effect produced by contact between the tools and the carbon of the fuel, as has been claimed.

It has been estimated by the F. W. Dodge Corporation that the building expenditures in the United States in 1925 reached $6,600,000,000, an increase of about $1,400,000,000 over those for 1924. To the extent of nearly $6,000,000,000 the figures are based upon actual contracts, the remainder being estimates on unreported work. New York led all the cities involved with the unprecedented outlay of $1,047,309,000, while Chicago came next in line with a sum of $427,417,500.

To foster export trade, the Polish government is hastening the construction of the harbor proper and of the various port facilities at Gdynia, the new seaport of Poland. Last year, Danzig, the only city that now offers an outlet to oversea trade, was not able to take care of the unusually great surplus of agricultural products.

MOFFAT TUNNEL SURE TO BE HOLED THROUGH ON TIME

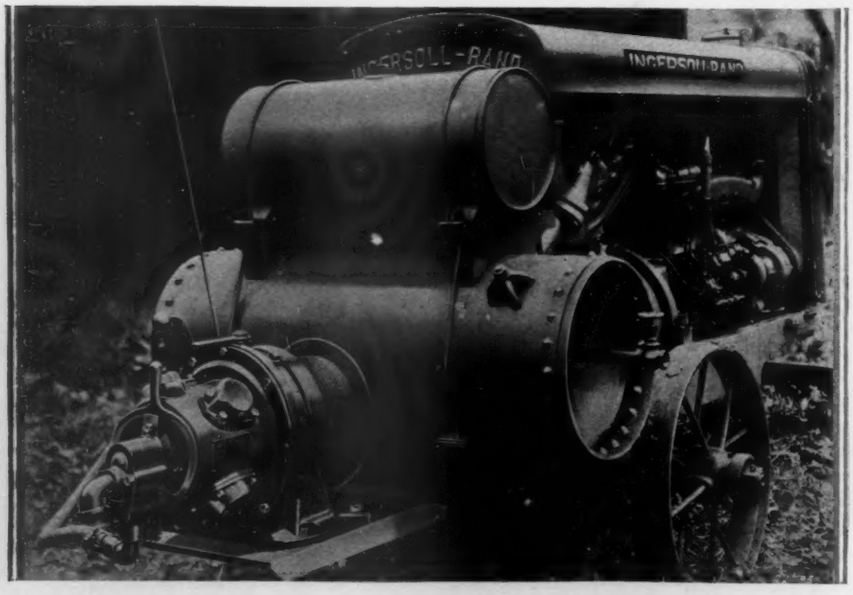
An aggregate advance of 2,000 feet a month is now being made at the headings in the east and the west portals; and enlargement operations in the railroad-tunnel section total nearly 1,000 feet a month. At this rate, the Continental Divide will be pierced by the first of July of the current year. Our left-hand center picture is of George Lewis, General Manager of the Moffat Tunnel Commission. The other photographs have to do with various phases of the great undertaking.

AIR HOIST FOR USE WITH PORTABLES

THERE has recently been put on the market, by the Ingersoll-Rand Company, a new air-motor hoist that has been designed especially for use with portable compressors. As shown by the accompanying illustrations, the hoist—known as the DU "Utility"—is so arranged that it can be attached either at the rear of the smaller types of portables or at the side of the units of larger size. It can also be used in connection with air compressors mounted on Ford trucks. Secured in this manner, the air hoist adds but little to the overall dimensions and to the weight of the compressor, but it does increase greatly the usefulness of the outfit, as a whole.

As can be readily appreciated, such a combination of air hoist and compressor is a decided improvement, as a portable so outfitted is capable of doing the numerous hauling and hoisting jobs that often accompany work calling for the services of a portable compressor. In roadbuilding, for example, the hoist can be used for hauling or for lifting rocks, boulders, trees, etc., from the right of way; for laying culverts; or for dragging a scraper when mucking or filling in on small jobs. In trench work it can be employed for hauling pipe lengths into position, for dragging in backfill, etc., while in construction work it may be utilized for hoisting building materials of one kind or another, such as structural steel, stone, concrete forms, and concrete. In short, the hoist can generally make itself useful wherever the services of a portable compressor are required.

"Utility" hoist mounted at the side of a portable compressor which, in its turn, is carried on a Ford truck.



Air-driven "Utility" hoist, Size DU, mounted at the rear end of a 5½x5-inch portable compressor.

To those interested in details, the "Utility" hoist is of the winch type, weighs 250 pounds, is 15 inches wide, 25⅜ inches long, and has a height of 19⅛ inches. The drum can accommodate 350 feet of 5/16-inch cable; and the hoist is capable of exerting a rope pull of 1,000 pounds. A swivel bolt through the bottom of the base permits the hoist to be swung around in any desired position. The machine is equipped with a clutch so that the cable can be readily played out by hand or by a downgrade load without turning over the motor and consuming air. A hand brake on the drum is provided to check the unwinding of the cable so as to stop the hoist at any desired point.

According to the manufacturer, the throttle control is so sensitive that any speed of rope travel—from the very slightest movement up to a maximum speed of 61 feet per minute—can be obtained even when carrying the full load of 1,000 pounds at an air pressure of 80 pounds per square inch. It is also claimed for the hoist that it is economical in the consumption of air. For example, when lowering a 1,000-pound pipe length into a trench, the hoist can be operated by a 5½x5-inch portable compressor that is supplying air at the same time to drive a Size 58 or a Size 158 pneumatic digger. A winch can be furnished in place of the rope drum.

LEATHER BELT WITH AN UNUSUAL RECORD

A LEATHER belt with 50 years of useful life to its credit! Such is the record of a belt that has been in well-nigh continuous use since 1876 in the Bernon Mills of the Manville-Jenckes Company, Georgiaville, R. I., manufacturers of cotton goods. This belt, which transmitted the power from a steam prime mover, was of 3 ply, 130 feet long, and 42 inches wide.

After its installation, the belt ran for a period of 35 years. At the end of that time it was found necessary to remove the ply nearest the pulley and to add another ply in its stead on the outside. From that date on it continued in service up to a few months ago, when the main shaft of the engine broke. It was then decided to discard the belt for a new one; but as it was still in good condition it was sold for the sum of $300 and cut up into smaller belts of various sizes.

The initial cost of this long-lived belt was $1,317.03, and the ply added in 1911 amounted to $600—making a total cost, after deducting the sale price, of $1,617.03, or $32.34 for each year of service. It has been estimated that in its half a century of usefulness the belt has traveled 9,387,200 miles.

Finland, now an independent republic, is a notable example to the rest of the world in the matter of a farseeing and successful policy of forestry conservation. Although Finland, so we are told in the *New York Lumber Trade Journal*, is the largest exporter of lumber in Europe, still her stands of timber are increasing year by year. The country's annual cutting is 1,143,000,000 cubic feet, while her annual growth amounts to 1,568,000,000 cubic feet.

Compressed Air Helps in Harbor Building

Pneumatic Equipment Are Employed in Many Ways in This Work

By F. A. COLLINS

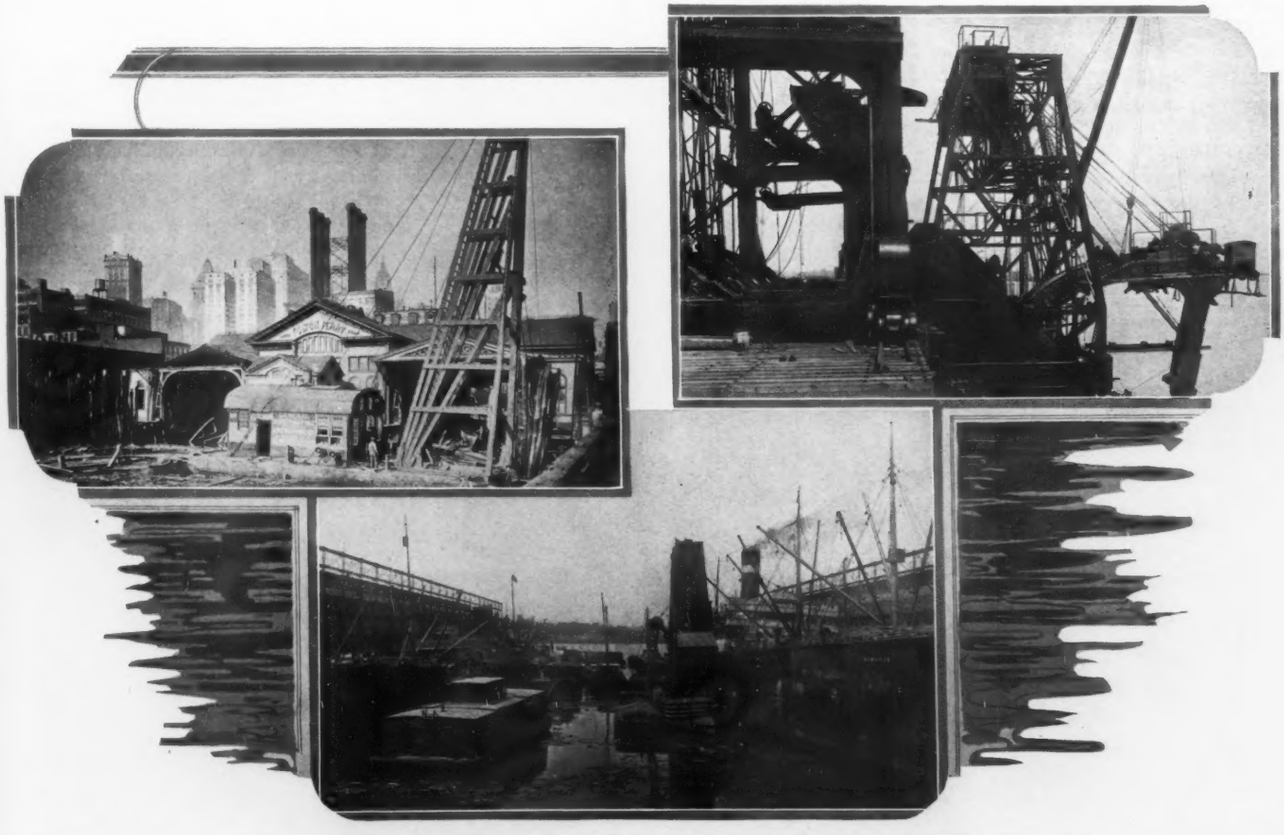
WHETHER Florida is facing a boom that may fall short of popular expectations, the fact remains that that state is going to develop industrially and as a winter resort far faster than it has done heretofore. To take care of the influx of permanent residents and to provide accommodations for the strictly seasonal population, Florida must make more of her ports and bring into being harbors having capacities and facilities much beyond those today available. Therefore, to do this work well and speedily it will be necessary to utilize machinery and other labor-lightening equipment especially suited to meeting conditions such as now exist not only in Florida but elsewhere along our seaboards where municipal and industrial growths demand improved port accommodations.

The rush to Florida has overtaxed the railroads—indeed, a freight embargo has incommoded for months the movement of supplies to points in that suddenly awakened part of our country. Even if this state of affairs should not occur again when Florida strikes a settled and full stride in her onward march, still congested rail traffic has emphasized the need of making the state more accessible by water routes. It will be of vital concern to her people to see to it that the stranding of a single craft shall not bottle up the one avenue of approach to an important harbor, as occurred not long ago.

Not only in the South, but elsewhere along our seaboards, land is being reclaimed, wharfs are being built, and harbors are being enlarged and even created to take care of expanding industry and the multiplying of craft of all sorts. It is dawning upon us more and more that water transportation has a bigger part to play in our economic life than has been the case in the past. Therefore, America's place in the maritime world will depend in large measure upon the skill of her engineers and the enterprise of her people in planning and in providing thoroughly up-to-date ports where shipping can be taken care of in a satisfactory and an expeditious manner.

It is not generally realized that the construction of harbors is a highly specialized branch of engineering; and the problem of outwitting the sea and of building practical harbors in exposed positions, where shipping may be safe from the severest storms, is fascinating. From the earliest times engineers have matched their wits against the sea. The ancient Phoenicians and, in turn, the Greeks and Romans expended a great deal of energy in harbor building; but of late the work has been simplified by the employment of ingenious labor-saving machinery. The use of steam, electricity, compressed air, and other forces, has given the present-day harbor builder an immense advantage in this ancient struggle with the sea.

The work of setting up sea walls and other barriers against storm-tossed waters, which will assure a safe haven for shipping, involves the mastering of many problems and the overcoming of many difficulties. "The wind bloweth where it listeth." It is impossible definitely to chart the currents of the



Left—Tearing down an old ferry building to make way for new piers on New York's East River waterfront.
Right—Great car-dumping installation which makes it possible to load floating craft with coal at a railroad terminal in the Port of New York. Compressed air was used extensively in assembling and erecting this coal-handling plant.
Bottom—Craft of many sorts crowd into the slips between the piers in the Port of New York.

Compressed air helped in many ways to construct these piers along the Hudson River waterfront of Lower Manhattan.

sea or certainly to predict the coming of storms and tidal waves. It has often happened that the best-laid plans of engineers—carried out at great expense and over a working period of years—have been wiped out in a few hours by some violent mood of the sea.

A careful study must first be made of the conditions along the seacoast, often for a period of years, before a harbor is even planned. The coast is first surveyed and the bed of the sea charted. The currents and tidal movements are noted under all weather conditions. These observations must be made accurately, and special instruments are designed for the purpose. The records must also include data covering several years on the destructive power of the tides and currents. The deposit of sand at various points is measured; and pilots, fishermen, and others living in the vicinity are asked for all possible information which may lead to a comprehensive understanding of local conditions.

Records are also kept in detail of the direction and the force of the prevailing winds. The height of waves in storms and their action on the shore line and the shipping are considered; and the history of storms that have swept the neighborhood in years past must be investigated. Again, on many coasts, unseen currents are continually changing the shore lines. The presence of a river, perhaps miles distant, may have an important influence. All these factors must be taken into account and comparisons made with the conditions that prevailed previously.

To outwit the sea two forms of barriers are generally erected, and these are classified broadly as jetties and breakwaters. Jetties are intended to assist in various ways to maintain channels at harbor entrances or at the mouths of rivers. They help to guide the rivers and to deepen the channels across the bars, or to resist the erosive action of the waves along the coast. Jetties are built of timber, metal, or stone, and they vary widely in form. All kinds of labor-saving machinery that are easily portable and can be operated in exposed positions prove especially valuable for such work.

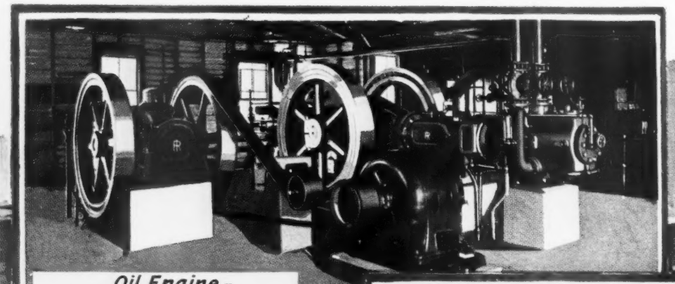
In combating the encroachment of the sea, breakwaters are employed. These may take the form of piers or may lie wholly below the surface of the water. The theory of the breakwater is that it will offer resistance to the undersides of the waves and thus break them up, or at least greatly diminish their force. Breakwaters usually bear the brunt of the attacks of the sea in the more exposed positions; and are commonly built of stone or concrete. There has been a great advance in recent years in this form of construction due to the use of modern machinery.

Perhaps the most difficult problem in harbor building is to design and to construct a safe entrance. A harbor must always be readily accessible from the sea. The entrance must be so placed and arranged that it will have ample depth of water at all times. During severe storms or high winds it is of the utmost importance that vessels should be able to pass safely into a harbor for shelter. The problem for the engineer becomes a harder one when a harbor opens directly on to the sea.

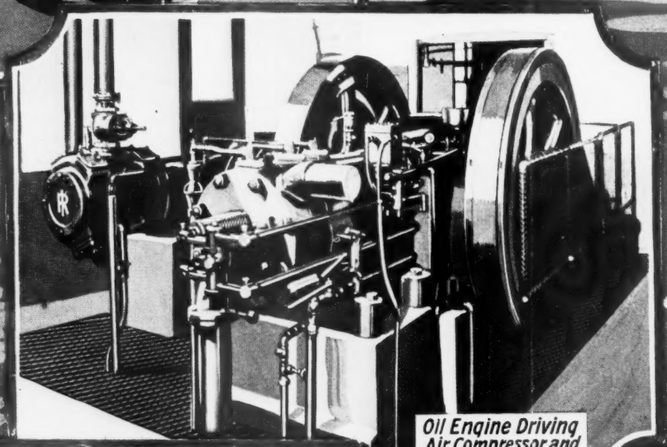
It will be readily understood that the old-fashioned cumbersome types of machinery are not adaptable to general harbor work. One of the first things to be done is to ascertain the nature of the sea bed. It is often necessary to explore below water for considerable depths, perhaps to drill through solid rock, to make certain of the exact nature of the foun-

Left—Launching a large caisson.
Right—Air locks rising above a submerged caisson.

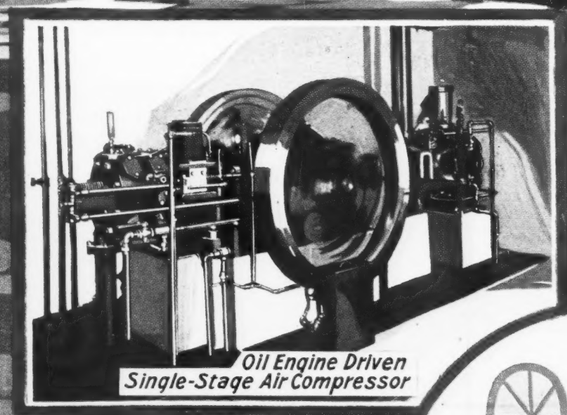
DIRECT-INJECTION OIL ENGINES FO



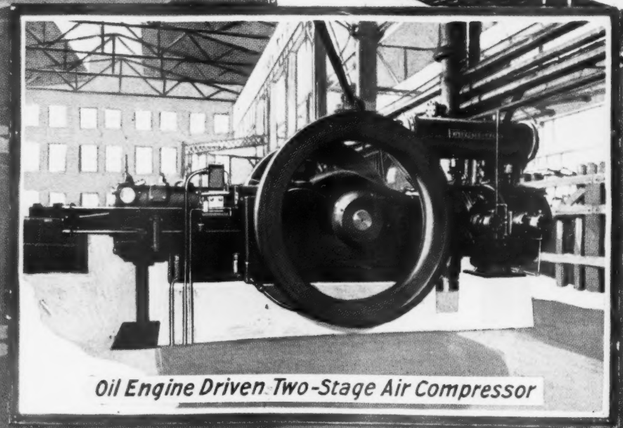
Oil Engine – Ammonia Compressor and Oil Engine Generator Set



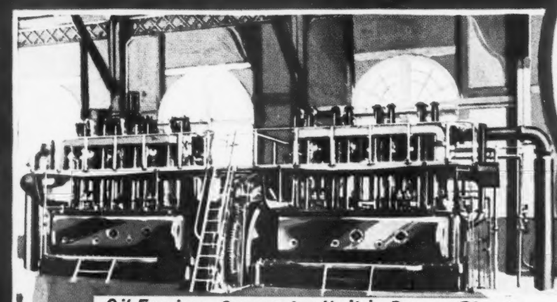
Oil Engine Driving Air Compressor and Centrifugal Pump



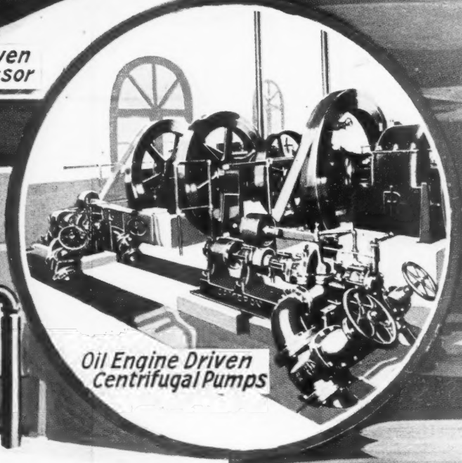
Oil Engine Driven Single-Stage Air Compressor



Oil Engine Driven Two-Stage Air Compressor



Oil Engine-Generator Unit in Power Plant



Oil Engine Driven Centrifugal Pumps

Ingersoll-Rand

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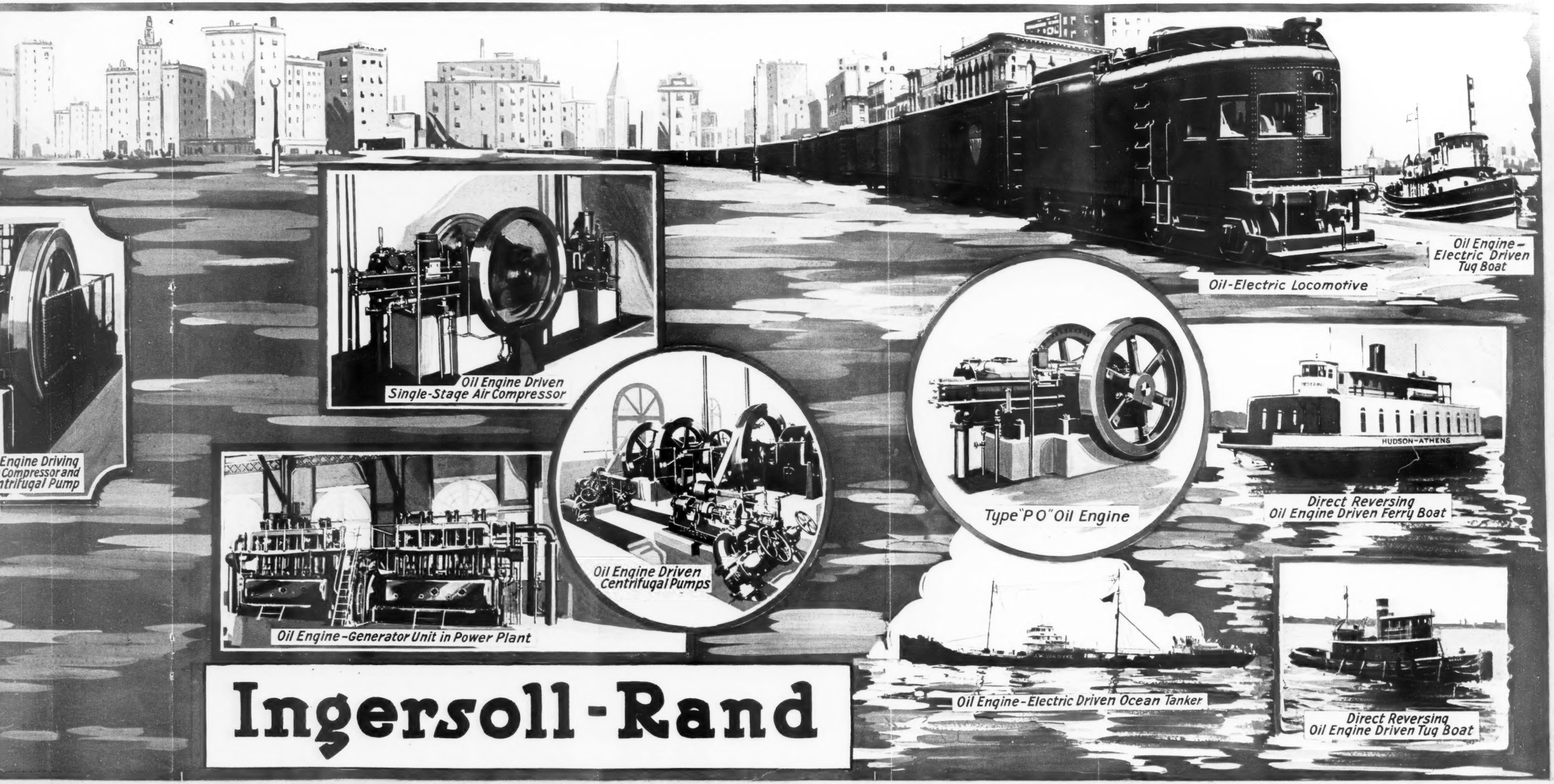


Ingersoll-Rand

THIS colored supplement has been reproduced because it shows graphically some of the many ways in which oil engines are now used for a variety of power purposes ⁂ The pictures serve to bring home to us in a measure the recognition won by oil engines because of their efficiency, their operating economy, and their great adaptability ⁂ This supplement was first used by the Ingersoll-Rand Company as a cover for a new bulletin describing its small horizontal oil engines. We understand that the Company, 11 Broadway, N.Y.C., will be glad to furnish a copy of this bulletin to any interested person, and will be equally pleased to send, upon request, complete descriptive bulletins of its large vertical stationary oil engines, its marine oil engines, or its oil-electric locomotives.

Left—Pumping compressed air down to a diver working at the bottom of a submerged trench. Right—The portable compressor has proved a handy and mobile power plant in harbor building.

dation for the jetties and piers. The drills are usually operated from the decks of craft moored above the point where the work is in progress. In this way, a cylinder of material may be cleanly cut from the bed of the sea by means of a core drill. This core will show at a glance the geological formation of the water bed for a considerable depth.

In most harbor work common use is made of piling which may be of concrete, wood, or steel. Under ordinary conditions pile driving is a slow, laborious job, but it is especially so when it must be done in exposed waters. It is often necessary to rush operations with all possible dispatch to forestall the coming of storms of wind or rain, with high seas, which may undo the effort of weeks in a few hours. The men must frequently labor against time.

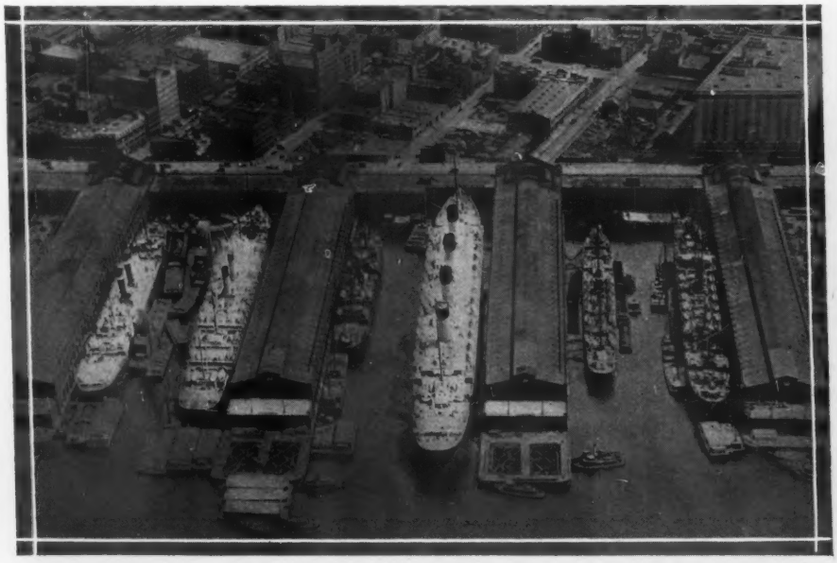
The old form of gravity pile driver is now usually supplanted by more modern machinery operated by compressed air. The new type of pile driver, being more compact, is readily carried to the desired position and set up where it may be needed; and, besides, it operates with a marked economy in time and labor. When the old-fashioned pile driver is used many of the piles are splintered and broken, and must be replaced. The modern method of sinking piles greatly reduces this element of loss.

The use of compressed air may prove of much value in driving piles in sand. The holes for the piles can be excavated or the material loosened with surprising speed through the joint action of a combined air-and-water jet. When the stream of water and compressed air is directed against the sand there is soon cleared a hole which will accommodate the pile on its downward course. Excavating jets of this sort will work equally well in either dry or wet sand; and a passageway is cleared or eased into which the pile can be driven with less effort and more rapidly than would be the case without this aid.

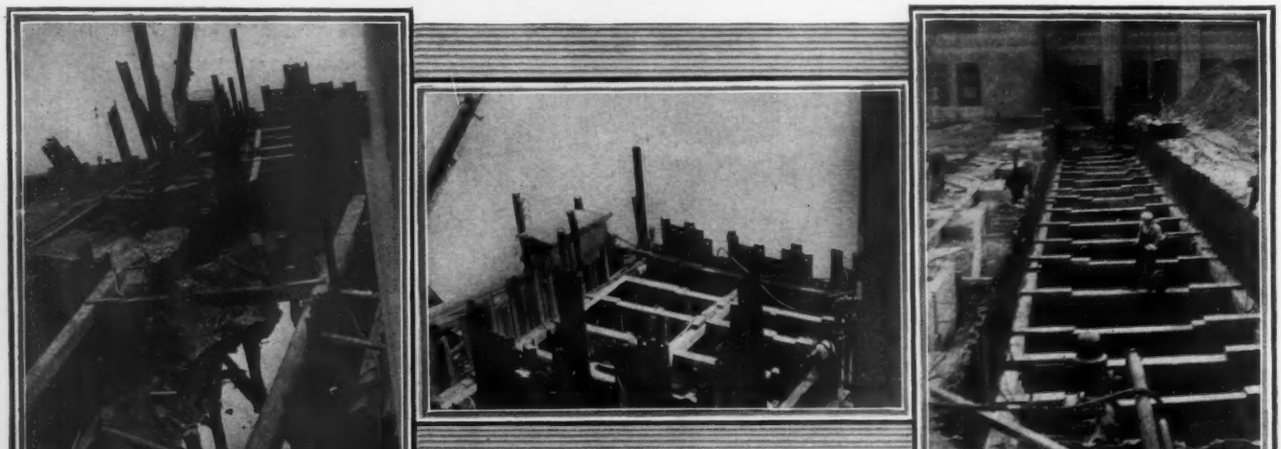
In harbor building there is an immense amount of drilling and boring to be done in materials of different kinds. Experience has demonstrated that this drilling can best be done by air-driven drills, especially when time saving is a matter of moment and the holes must be drilled in places where it would be hard or awkward to do the work by hand. Not infrequently, one man equipped with a pneumatic drill or wood borer will do, in the course of a day, work which would otherwise require a good many men to finish in the same period of time.

In making surveys of river bottoms or coastal sea beds, and in planning harbor work, it is often necessary to employ divers and, occassionally, diving bells. The pumps or compressors now used to furnish the needful air for such operations represent a great advance over the compressors or pumps utilized up to a comparatively short while ago. The air for men working under water is now supplied in ample measure and without any marked variation in pressure, where formerly the drop in the air pressure and the reduction in the volume of air constituted a real peril. Divers are sometimes employed to inspect subsurface parts of breakwaters, jetties, and sea walls.

Caissons are often used in some of the work incidental to harbor building, that is to say,



This picture of a section of the North River waterfront in the Port of New York gives an excellent idea of the magnitude of modern docking facilities for great ocean-going liners.



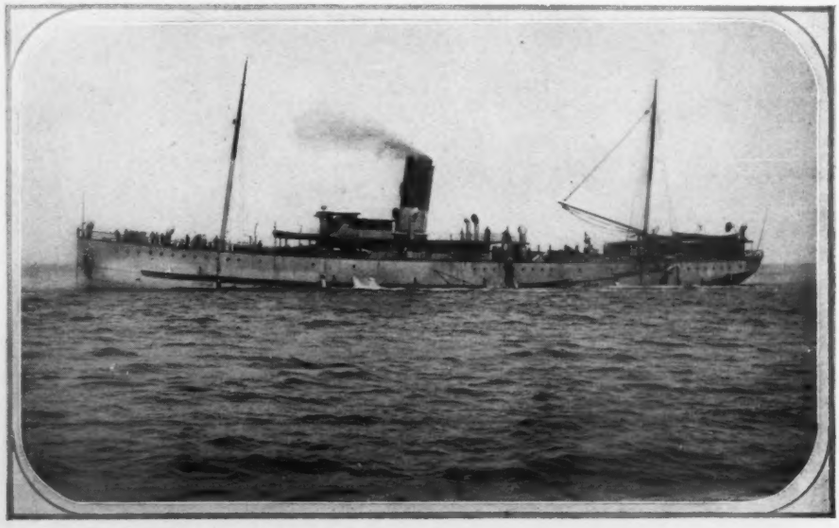
Left—This derrick, used during dock-building operations, had an air-driven hoisting engine. Center—The pumps that drained this cofferdam were operated with compressed air. Right—The steel sheet piling flanking this trench was driven with a pneumatic hammer.

in doing some of the many things that go to make up a properly equipped port. There was a time not so far back when caisson sinking could be done successfully only in thoroughly sheltered waters; but nowadays caissons are utilized in subaqueous work at decidedly exposed points. No small part of this wider use of the caisson is due to the fact that compressors are now available which can be installed upon a craft and can be relied upon to provide a plenty of air for the operations in hand.

The modern and efficient air-driven tools that are to be had for digging, boring, riveting, hoisting, etc., are admirably suited for harbor-building undertakings. As work of this nature must often be carried forward in rather exposed positions and between periods of stormy weather, anything that will promote speedy accomplishment is highly desirable. Therefore, the entire field of labor-saving machinery is scanned for the purpose of discovering new methods or new facilities that will shorten the time of construction.

The value of air-driven machinery has been well demonstrated recently in certain work still in progress in the Port of New York. A large section of Jamaica Bay, on the south shore of Long Island, is being reclaimed for dock purposes. It has been found necessary to build extensive bulkheads so as to create new channels and to afford the desired docking facilities. The bulkheads are formed of heavy timbers bound together by bolts. The work has been greatly facilitated by using air-driven tools and machinery—the power for operating them being supplied by air compressors placed on the decks of scows.

The building of harbors under varying conditions now attracts the best engineering skill of the country. Until recently, undertakings of this kind in the United States were carried out either by or under the supervision of Government engineers. However, with the rapidly increasing demand for harbor development, many engineers began to specialize in this particular field, and today much of this work is executed under the guidance of men trained in the Government service but employed by municipal authorities. There are several engineering firms in the country that virtually confine their activities to harbor building; and these concerns are fully alive to the value of compressed air and of pneumatic equipment in putting through their various contracts expeditiously.



This type of dredge is used in harbor work by the United States Army Engineers. The boat sucks up mud and fills her hold, after which she runs seaward and discharges the mud in deep water.

BED OF ABANDONED RAILWAY NOW A MOTOR ROAD

THE roadbed of the Midland Railroad of Colorado, having been abandoned, has been converted into a public highway. This highway passes through some of the most picturesque parts of the state and extends from Colorado Springs to Glenwood Springs, reaching the famous fishing country of the Frying Pan and the Roaring Fork rivers. An irrigation project has also taken advantage of the route for the purpose of conveying water from lakes Topaz and Ivanhoe to thousands of arid acres in the Arkansas Valley. The highway and the waterway go through the Busk-Ivanhoe Tunnel, which is two miles long and so straight that it can be sighted through from end to end.

As the railroad was a 1-track line, the present traffic through the tunnel can go but one way at a time. Therefore, a clock at either end times the trips, each of about twenty minutes' duration, which are scheduled to start at one end on the hour and at the other end on the half-hour.

The fifth International Road Congress will be held in September of this year in Milan, Italy. A road exhibition is to take place concurrently with the Congress, which is to be attended by delegates from the larger European countries. The road exhibition will afford an opportunity to American firms, with representatives in Europe, to show their products.

Exploratory Deep-Hole Drilling

By R. K. BROWN*

MANY inquiries have been received relative to the practices resorted to and the results obtained in drilling deep holes with drifter machines. The only purposes for which deep holes have been employed at the Tonopah Belmont are prospecting and sampling; but deep holes are applicable to other and varied services, such, for example, as drainage of mine water, stope ventilation, pilot holes, and rescue work in supplying air and food to entombed miners. No doubt many other uses will present themselves. In stope ventilation a larger bit would be required.

Deep holes as prospect holes serve two purposes: for prospecting in virgin ground, and in prospecting for faulted segments of known veins. In the former case, a hole, elevated 10 degrees, is drilled from the face of a crosscut. This is a limit hole. If values should be encountered, another hole is drilled on a different course to determine the strike of the vein; and then a third hole, elevated 30 degrees, will show the dip. In prospecting for faulted segments, the direction of throw being nearly certain, a hole is drilled along the fault to determine how far the vein has been faulted. This will also indicate the best point from which to mine that segment.

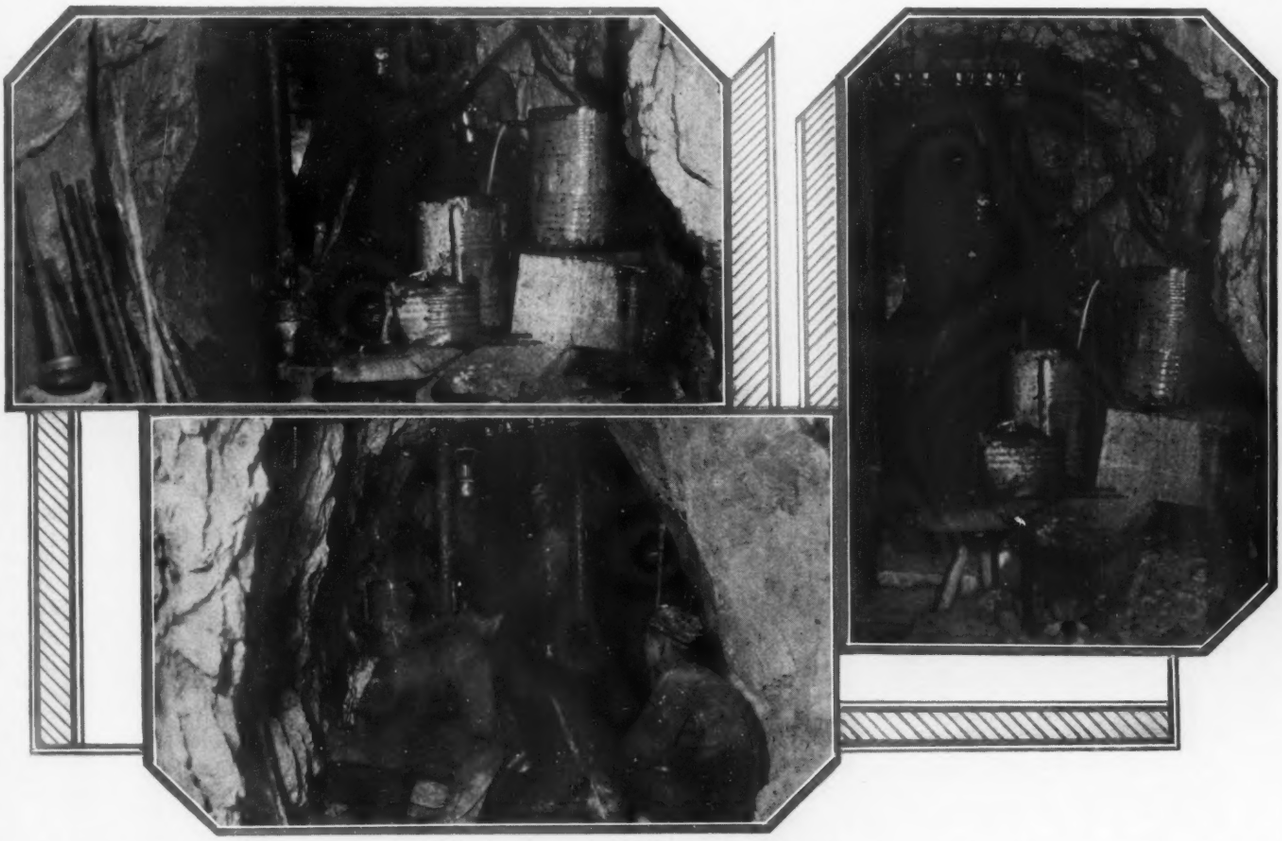
Deep holes as sample holes determine the commercial value of known veins. A vein of low values, upon which no drifting or raising has been done, can be sampled 100 feet or more on both sides of the crosscut and 50 feet or more above it. Veins appearing on one level but not cut on the level below are sampled from the lower level, with a hole elevated 40 or 50 degrees, to determine whether it is practicable to underhand or raise and stope from below.

At the Tonopah Belmont three machines are being operated, and each outfit has the following equipment.

1 Type S-80 drifter, mounted on 42-in. feed shell.
2 4½-in. by 6-ft. columns connected by 4½-in. by 2¼-ft. arm.
1 Water swivel set in guides, clamped to fronthead.
34 Rods: 2 of 1¼ in. by 3 ft.; 2 of 6 ft.; 20 of 9 ft.; and 10 of 15 ft., used when space will permit. Rods have 3½ in. of left-handed threads.
24 Couplings.
1 8-point rose starter with 3½-in. gage. Cross bits are sized 1 to 9, with gage 3¼ in. down to 2¼ in. The sharp corners on the points are pounded down to a 5-degree angle to permit driving.
200 Ft. of 1-in. pipe cut in 10-ft. lengths for fishing broken rods.
2 1½-in. by 18-in. pipes reduced and welded to 1-in. fitting. This fishing tool is split 1 in. and belled to receive couplings, and crimped 8 in. back to hold 1¼-in. rods.
1 3-in. by 16-in. pipe split: 4 in. from end cut ¾ through and 12-in. section rolled out as a launder.
3 Cans of different heights, two of which have a ¾-in. nipple 2 inches from the top.
2 24-in. Stillson wrenches.

The course of the hole is laid out, front and back sight being smoked on the walls. The column, with collar attached, is set up and blocked, after which the cross arm—set at right angles to the course of the hole—is clamped on. The other column is set up and clamped to the arm, after which it is blocked into place. When securely held by blocking, the arm clamp on the second column is released; the column jacked tight; and the arm clamp pulled up snugly. The machine is lined to the course of the hole and elevated to whatever angle may be required.

A 3-foot rod and a rose starter are screwed into the water sleeve, and the hole is marked. Three inches directly underneath, a hole is



Pictures at top and right show the way in which a series of three cans is utilized to catch the sludge from the drill hole so that the slimes can be examined for metallic values. Bottom picture illustrates the manner in which the rock drill is mounted in driving exploratory holes.

*Engineer in Charge, Tonopah Belmont Development Company.

drilled, 6 inches deep, and a 3-inch pipe launder is then inserted. The machine is brought back into position and drilling started. The sludge is caught in a can, 12 inches in circumference by 24 inches high, which empties into a shorter can, the overflow from which drains into a still shorter can. This method has been adopted as a precaution against loss of values in slimes. The cans are changed every 3 feet of drilling; and the contents of the two smaller cans are dumped into the larger one and allowed to settle. Next, the clear water is decanted and a sample taken in a pan 6 inches in circumference by 2 inches deep. This sample is placed in a case, which is partitioned off to hold 16 pans.

When the 3-foot rod and bit have been cranked out, the rod is removed; the machine backed down; and a 6-foot rod inserted which, in turn, is taken out and replaced by a 9-foot rod. This process is repeated until the bit becomes dull, when the entire string is pulled and a new bit put on. The depth of hole desired determines the depth to be drilled with each size of bit. For a hole over 200 feet deep, Sizes 1 and 2 bits drill at least 80 feet, and as many of each succeeding size are used as the nature of the ground may warrant in order to insure the depth to be attained. In the case of a hole 75 feet deep, 30 feet is drilled with Sizes 1 and 2, and thereafter one bit of each size is employed, as no driving is required. After driving a bit to the bottom of the hole it is necessary for the helper, with a Stillson wrench, to assist until rotation starts.

Rod breakage appeared an important factor in the earlier stages. Last September, 12.47 per cent. of the total time was required for fishing; in October, 5.39 per cent.; and in November, 4.08 per cent., while actual drilling time increased from 68.11 per cent. in September to 79.73 per cent. in November. Each fishing job presents its own problem. The method usually followed is to insert the fishing tool of 1½-inch pipe; to add 1-inch piping until it touches the broken end of the rod; and then to drive on tightly with the machine. The machine is cranked back about an inch, and the 1-inch pipe turned with a Stillson until a joint breaks. This is easily detected, as the pipe will back up against the machine when the rod coupling unscrews. The broken member is pulled out, the rods inserted, and the remaining string of rods picked up.

In November, every hole drilled reached the depth desired. In one instance, at 103 feet, an open crevice was encountered and all sludge lost. The hole was continued for several feet in the hope that additional cuttings would seal the opening; but this was abandoned and a new hole, 5 degrees to the left, was drilled until it reached 225 feet. We have not been bothered with "ravelly" ground, probably for the reason that there is no backward and forward movement of the rods, which are cranked up fairly snug against the ground at all times.

The deepest hole drilled to date is 256 feet. Work on it was stopped on account of extremely hard rock which made bit changes frequent. Holes elevated 40 degrees have been drilled for 111 feet. We do not know what maximum depth is possible, as we have not reached the capacity of the machine either on a 10 degree or a 40 degree elevation. It has been found that the hole will clean itself of sludge at an elevation of 10 degrees; and as a consequence, in changing bits, the rods push in much easier. Holes drilled at a lesser angle need to be washed out, using ¾-inch pipe for the purpose. We have a hole laid out which must reach a depth of at least 300 feet, and we see no obstacle which will prevent that depth from being attained.

DETAILED REPORT FOR MONTH OF NOVEMBER

	Shifts	Hours	Per cent.
Moving	7	6	9.04
Drilling	68	3	79.73
Fishing	3	4	4.08
Machine repair*	1	3	1.62
Cleaning hole	2	½	2.40
No air	0	5	.73
No water	2	½	2.40
Total	85	6	100.00

Total footage drilled	2,345
Average footage drilled per shift	27
Feet per drill shift	34
Average footage per bit	6.4

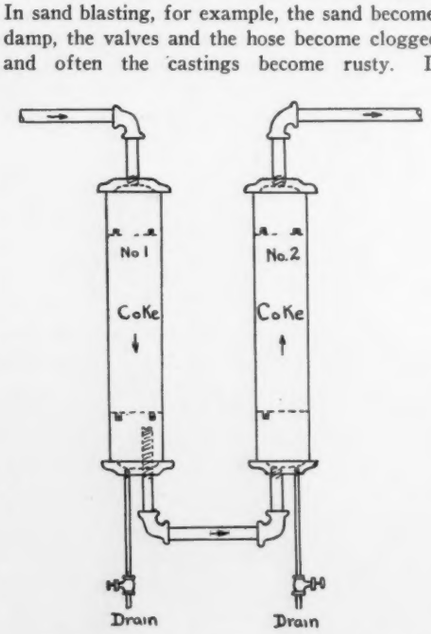
Bits	Gage	Footage
19 Rose	3½	55
83	3¼	643
65	3⅛	419
58	3	293
49	2⅞	278
33	2¾	223
28	2⅝	236
21	2½	141
9	2⅜	57
365		2,345

**Machine repair includes riveted shanks, packing water swivel, injury to feed screw through carelessness, etc. Two small washers in ratchet-gear case were the only replacements in ten months of operation.*

EASILY MADE AIR FILTER FOR STOVE PLANT

By J. RUSSELL YOCOM*

THE presence of water in compressed air may be the cause of more or less trouble. In sand blasting, for example, the sand becomes damp, the valves and the hose become clogged, and often the castings become rusty. In enameling and painting with compressed air too much water has injurious effects. The first coat of enamel may stay on a rusty casting, but after the second coat has been applied and burned on the enamel in many cases peels off. Sometimes the finished product reaches the customer before there are serious results. The presence of water, together with numerous minor troubles, tends to increase production costs, and may even affect the manufacturer's reputation.



Type of air filter that has been found efficient when handling about 450 cubic feet of air per minute.

**Chief Machinist, Buckwalter Stove Company.*

The writer has used a variety of condensers with varied success; and has been much impressed with the performance of coke filters, which should, of course, be installed as near as possible to the point where the air is used. A filter of this kind can be built in any small shop. The accompanying sketch illustrates a type of coke filter that has been found practical for taking care of the air produced by a compressor with a capacity of about 450 cubic feet per minute.

As can be seen, the two tanks are alike—the body of each being made of a piece of 10-inch pipe, 5 feet long, and threaded at each end. Inside the pipe, 10 inches from each end, are fastened round plates. These plates, the diameter of which is slightly smaller than that of the inside of the pipe, are made of ¼-inch wrought-iron plate and are perforated with $^{9}/_{32}$-inch holes about 1 inch apart. Four brackets, made of ¼x1¼-inch flat iron, are bolted or riveted to the plates 90 degrees apart. Four ⅜-inch holes are then drilled and tapped near each end of the pipe. Care should be taken to get these holes on the quarter circle and at a distance from each end so that each plate will set in about 10 inches. The plate is then set in its proper place, and the holes are laid out on the brackets by scribing through the ⅜-inch tapped holes. Holes, $^{13}/_{32}$ inch, are next drilled in the brackets, and the plates are then fastened with ⅜-inch cap screws the ends of which are riveted over on the outside of the pipe. Before the second plate is fastened, the coke is put in the middle space. The coke used should be in pieces about the size of a walnut. The tank ends are standard 10-inch pipe caps. The top end of each pipe is drilled in the center and tapped with a 2-inch pipe tap, while the bottom end has a 2-inch pipe tap off center on one side, and a ¾-inch pipe tap off center on the opposite side.

The compressed air enters at the top and passes out at the bottom of Tank No. 1, entering at the bottom and passing out at the top of Tank No. 2. The ¾-inch pipe at the bottom of each tank drains the water into any convenient drain—the drain valves being so placed that they may be reached from the floor. The 2-inch pipe in the bottom of Tank No. 1 has a thread 6 inches long so that the pipe may be screwed in with about 5 inches projecting through the cap. This is done so that the water draining to the bottom of Tank No. 1 will not pass through the pipe and into Tank No. 2.

(Editor's Note: A filter of this type may prove satisfactory for the class of work in question, but it does not necessarily follow that it would be equally effective in other departments of industry.)

Wooden Building Gets New Lease of Life

By A. M. HOFFMANN

FRAME buildings used for industrial purposes and located in congested districts are now looked upon with disfavor. As a matter of fact, it might be said that the day of frame buildings for manufacturing and the like is on the wane because of the risk they represent in case of fire.

Be this as it may, what is to be done about the thousands of solidly built wooden structures of this kind that are still standing and that have years of useful life ahead of them? This question has been answered for us recently in a practical way; and once more we are reminded of the debt we owe to concrete and to the modern methods of its application. Thanks to the ease with which fluid concrete can be applied to vertical walls, it is now possible to utilize that material to cover wooden structures with a fire-resisting coating that has been proved effective against the attack of sparks and flames.

Frame car-repair shop before it was fireproofed by giving it a concrete coating.

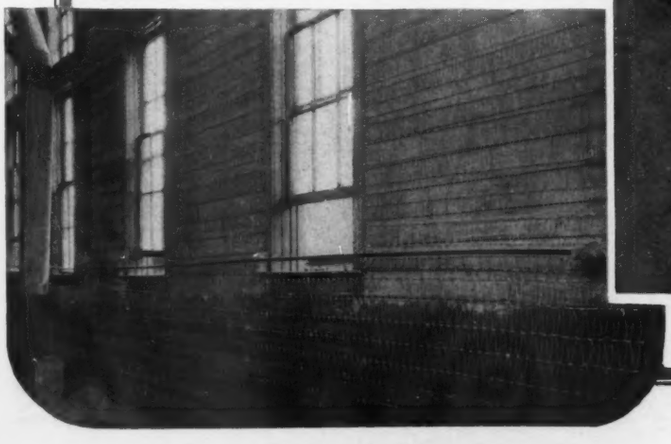
A wooden car-repair house, at Joliet, Ill., belonging to the Elgin, Joliet and Eastern Railway Company, was believed to constitute a fire hazard, and was the only one of its kind in the midst of a number of other buildings which were of fire-resisting construction. The management was in a quandary. In the first place, to tear the structure down and to erect an all-steel repair house in its stead would have entailed too great an expenditure; and, in the second place, the shop was much in demand—the incidental interruption to service would have been a serious handicap to the road. After considerable deliberation it was decided to take advantage of a modern method of making frame walls more resistant to fire by forcibly plastering them with concrete by means of compressed air.

To begin with, all weather-boarded surfaces on the inside and the outside of the walls and on the partitioning walls were covered with galvanized wire mesh, triangular in pattern. And right here it might be mentioned that the repair house, which was constructed in 1909 and in good condition, has a width of 37 feet and a length of 300 feet, while the side and the center posts are, respectively, 19 and 23 feet high. These figures give a good idea of the amount of wall surface that had to be concreted. The wire mesh was securely nailed in place—furring posts being employed to keep the latticework about half an inch away from the boards.

And now we come to the actual application of the so-called "gun-crete," which consisted of a mix of 1 part Portland cement and 3 parts clean, sharp sand. This fluid material was shot into place, with the least possible delay, by means of air-operated cement guns—the air being at a pressure of 60 pounds to the square inch. In this way the entire wall surfaces of the building were given a coating of concrete ¾-inch thick.

Most of us can readily recall other frame buildings more or less similarly situated and in well-nigh daily use that are, from the very nature of the material used in their get-up, fire risks that occasion intermittent if not continual concern to their owners or neighboring property holders. What has been done in the case of the particular shop mentioned can, in all probability, be repeated to advantage in these other instances—thus converting inflammable wooden buildings into buildings that would be relatively fireproof or fire-resisting.

A notable event in the Canadian mining industry in 1925 was the discovery of new copper-gold deposits in northwestern Quebec. This ore zone extends in horseshoe shape through a number of townships; and some of the claims are said to promise well for future development.



Interior of building with triangular wire mesh in position preparatory to coating the wall with concrete

Exterior of the frame building during the process of fireproofing it with concrete shot into place with compressed air.

Steel Tubes Driven with Air to Bedrock Support Skyscrapers

By THE STAFF

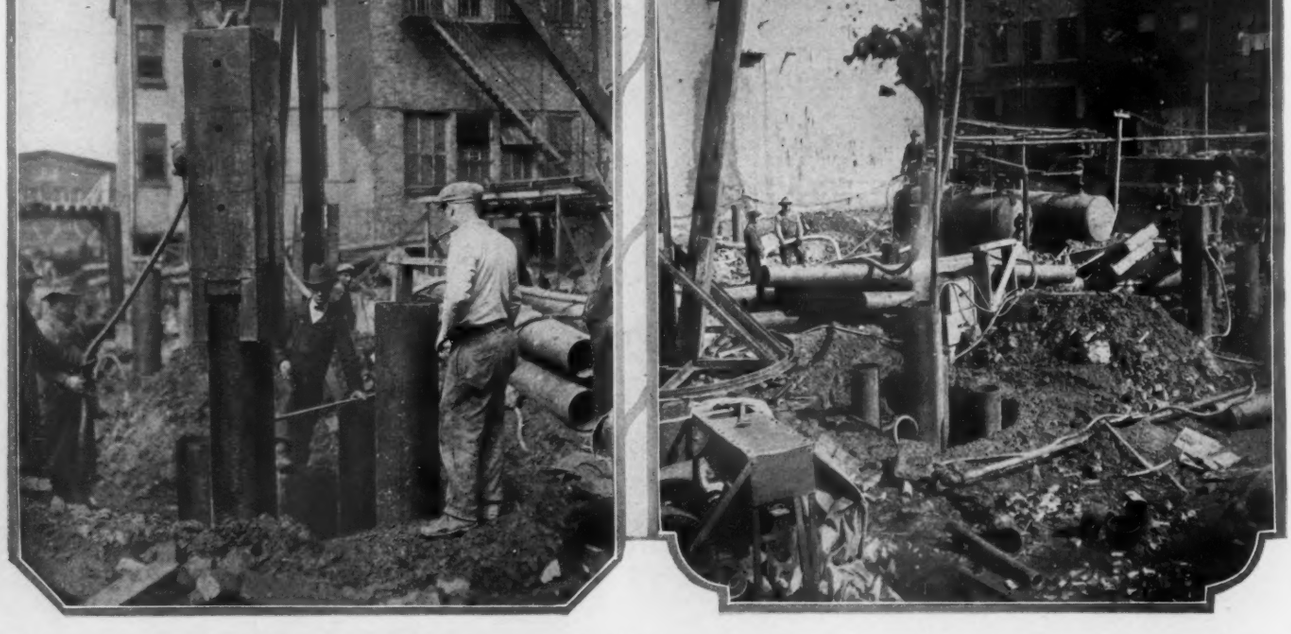
A CASUAL visitor invariably is amazed by the kaleidoscopic nature of New York's skyline. Tall buildings are continually giving way to still larger structures in order to keep pace with the expansion, especially in the business section, of the Metropolis. In this continuous shifting of scenes, speed of operation is a vital factor. But still another factor of even greater importance in the rearing of buildings is that of economy. The enormous values placed on real property, particularly in Lower Manhattan, forces a builder of a skyscraper to look well into the matter of cost in order that he may be able to make a reasonable profit on his investment.

One of the logical outcomes of this need for speed and for economy is the substitution of concrete-filled steel tubes for the familiar concrete piers in forming the foundation for a new building or in underpinning either the foundation of an old structure, to which a story or two is to be added, or the walls adjacent to a new building in course of construction. Of course, geological conditions sometimes make it imperative to resort to the caisson method of sinking the necessary supporting piling; but, in most cases, groups of steel tubes, driven to bedrock from the surface and then filled with concrete, are found to be entirely satisfactory.

Depending on the size of the undertaking, the ⅜-inch tubing used for the purpose varies anywhere from 10 to 16 inches in diameter and is cut in lengths ranging from 17 to 23 feet. The method of sinking a tube is in no wise complicated, and in this work compressed air plays a part as it does when a caisson is employed. The tube is first driven through the earth—sand, gravel, or clay, whatever its nature may be—with a compressed-air hammer that assures measured and uniform blows. And right here it might be mentioned that after a tube has found a firm footing, and before the top is cut off, it is subjected to further hammer blows under the supervision of an inspector to make certain that it has reached bedrock.

In the case of the job that inspired this article, the Underpinning & Foundation Company used the "tuba" method in forming the foundation for a new building. After a tube had been driven to bedrock, then a 2½-inch blowpipe—suspended by a rope attached to a derrick arm—was lowered into the tube. At the top of this blowpipe, a considerable portion of which projected from the tube, there was an elbow to which was fastened an air line leading to two large interconnected receivers. As soon as the lower end of the blowpipe had buried its nose in the ground within the tube, compressed air at a pressure of 100 pounds to the square inch was quickly released from the nearby receivers. The result was an explosive action, the force of which was sufficient to blow the contained material out of the tube. This process was repeated as often as necessary to get rid of all the earth in the tube. One of the accompanying illustrations gives a good idea of the force with which the material is blown skyward by the air.

As previously mentioned, the tubes are sunk in groups—the number in a group depending on the proportion of the total deadweight that each is designed to carry. For example, a group of 4 concrete-filled steel tubes, each having a diameter of 15 inches, is capable of bearing a deadweight of 400 tons. After the tops have been cut off and the tubes have been filled with concrete, each group is bound together by a reinforced-concrete cap. Piles of this kind, whether they must be driven 10 feet or 80 feet to reach bedrock, can be counted upon to carry their prescribed load. In contrast with the caisson method of pile sinking, a saving of approximately 50 per cent. in both time and cost is claimed for the "tuba" system.



Left—Before the driven tubes are cut off they are tested with a pneumatic pile driver to make sure that they are resting upon bedrock.
Right—After the tubes are in place they are cleaned out with a compressed-air blowpipe and then filled from top to bottom with concrete.

Putting Power of Georgia's Rivers to Work

Terrora Development is One More Link in a Chain of Stations on Tallulah and Tugalo Rivers

PART II

By JAMES E. O'ROURKE*

WHEN this approach was started, the air compressor was still in course of erection; and, therefore, in order to expedite drilling as much as possible, a 15-H.P. boiler was installed to furnish steam for a piston drill mounted on a tripod. This greatly increased the progress over that obtained with hand steel and double jack; but the real impetus was secured when the air compressor was started and X-70 drifters and DCR-23 "Jackhamers" replaced the piston drill on August 9, 1923. This approach was finished on August 23, and the actual attack on the adit was started the day following.

The adit was driven 8½ feet high by 10 feet wide, and was completed to the point of intersection with the main tunnel on September 29, 1923. Working 6 days a week, 33 working days were required for the completion of this entry. The rock formation throughout its entire length was a very close-grained and extremely hard mica gneiss. The drilling was done with X-70 drifters mounted on a crossbar. Three machines were used on each shift—the working day being divided into two 10-hour shifts, and two 5-foot rounds were broken daily.

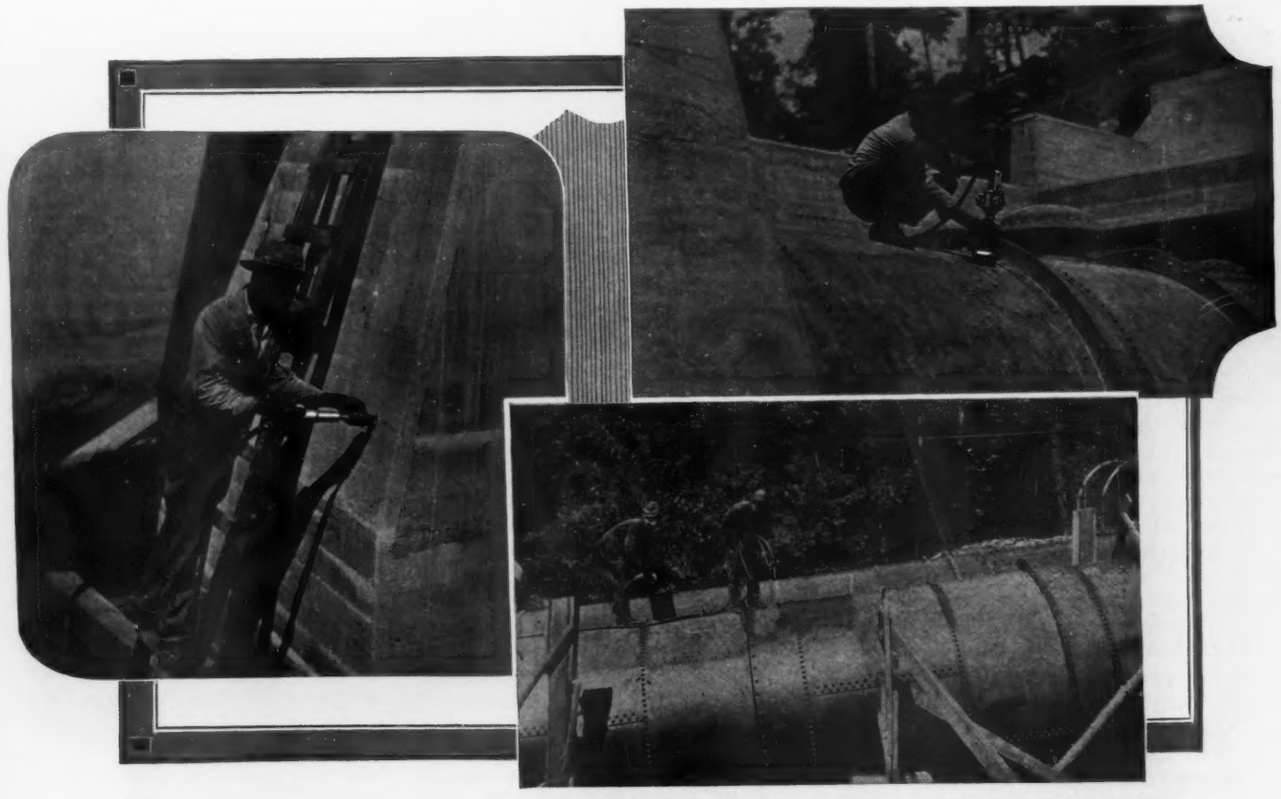
IN DRIVING the Terrora tunnel, the use of mechanical loaders was considered when planning for the removal of tunnel muck, but it was finally decided to do the work by hand—employing negro labor for the purpose.

As it turned out, the labor cost per foot of tunnel was just about equal to what the initial investment per foot of tunnel would have been had mechanical loaders been bought. The southern darky is not a notoriously energetic worker, and it takes a deal of coaxing to make him do his physical best. The performance, in the present instance, indicates that skilful superintendence was the means of getting him into "high gear."

Attack on the main tunnel of the Terrora development was started at the Lakemont end on October 1, 1923. Meanwhile, between July 12 and September 11 of that year, the tunnel organization at the Sawtooth end succeeded in driving 200 linear feet of tunnel from the outlet portal. This part of the bore comprises 3 different sections, namely: 161 linear feet of penstock tunnel 14 feet high and 27 feet wide; 17 linear feet of transition, which increased in section from 14x27 feet to 16x40 feet; and 22 linear feet under the surge tank, having a height of 16 feet and a width of 40 feet. This advance was made through soft ground which required careful timbering.

Actual attack on the main tunnel bore was begun at the Sawtooth end on September 12. Fortunately, the rock formation encountered just beyond the surge tank was of a much harder nature and required but two sets of segmental arch timber; and the DCR-23 "Jackhamers," which had been previously employed

Resident Superintendent, Terrora Development.



Left—Removing fins from concrete with an air-driven scaling hammer equipped with a bush-hammer bit. Top—Cleaning the surface of a penstock with a pneumatic wire brush preparatory to painting the metal. Bottom—Painting penstocks with an air gun.

in drilling the soft ground, were replaced with X-70 drifters.

A few of the drillers employed at the outset had previously operated mounted hammer drills in mining work, but practically none of them had had any experience in modern tunnel driving. It was, therefore, something of a task to convince most of them that the drill holes in a tunnel heading had to be placed with the utmost precision in order to secure effective results. As a means of assisting them to grasp the idea of a standardized round of holes, a full-sized model of the tunnel heading was constructed and erected on the dump adjacent to the change house. Loading sticks were used to represent the holes.

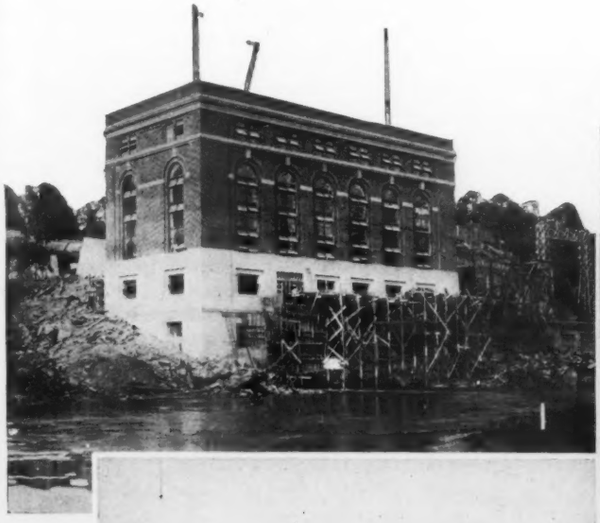
The heading foremen were instructed carefully in regard to the need of absolutely maintaining a certain set distance between the collars of the cut holes and likewise between the back centers of the feed screws of the two machines "lined up" on parallel cut holes. In our particular case these measurements were 6½ feet and 11 feet, respectively. The same general caution was exercised in regard to relievers, and rib and arch holes. As a further expedient, during the first two or three months, and occasionally thereafter, each heading foreman returned to the face in company with the superintendent or walking boss after the smoke had cleared sufficiently, and a *post mortem* examination was made of the blasted round. This close study led to the persistent drilling of almost perfect rounds in which each hole carried a uniform burden after the "cuts" were pulled.

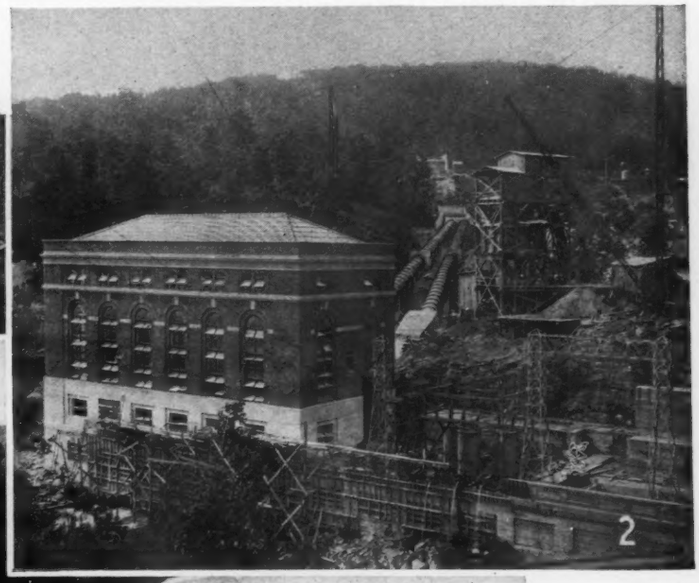
Grade hubs were carried in the roof. Plummet lamps were used in taking center and grade, and these lamps were adjusted to spring-line elevation on the center line. In order to avoid confusion, the lamp which was always used in the forward position was painted red. Overbreak was greatly reduced by painting the neat line of the arch after each shot. As a further guide for the heading foreman in the proper location of his holes, a perpendicular center line was painted on the heading face with a horizontal paint mark at the spring-line elevation. Almost a perfect arch was obtained as a result of these precautions; and our records show that only 57 sticks of 1¼-inch gelatine were required in trimming the entire tunnel after the connection was made.

The top-heading-and-bench method of attack was employed throughout the entire job. A top heading 9 feet high by 13 feet wide was carried about 45 feet in advance of the face of the bench, which was 6 feet in height. All mucking was done by hand by negro laborers under the guidance of white foremen. Two drilling crews were employed daily during each 6-day week in drilling and shooting the faces; and two regular mucking crews were employed in removing the spoil. In addition to the regular mucking crews, a special mucking crew of 8 men worked a split shift. This crew entered the tunnel about 20 minutes after each shot was made and "mucked back" the broken rock from the heading face, thereby securing a clean place for the set-up of the vertical columns on which the drilling machines were mounted for the next drilling operation. This special mucking crew effected a great saving, inasmuch as the work performed by them permitted the drilling crews to start drilling operations without unnecessary delay.

Two rounds, each of 26 holes, were drilled and shot in each heading every 24 hours; and an average advance per round of 6 linear feet was obtained—that is, a total of 12 feet of heading advance per day. A corresponding advance of 12 feet per day of bench excavation was obtained by drilling and shooting a long round daily of horizontal holes consisting of 3 splitting and 3 lifter holes. This procedure made it possible to maintain at all times the same relative length of bench. This method of drilling and blasting scattered the muck at two points, namely, on top of the bench and on the tunnel floor. Because of this, it was possible to spread the mucking laborers over the two places and thus to secure the most efficient mucking performance per man. Four cars, having a capacity of 25 cubic feet, were loaded simultaneously. The two cars which were spotted nearest the bench face, on separate tracks, were loaded with rock shoveled directly from the tunnel floor, while the two rear cars were filled with rock from the top of the bench that had been shoveled into wheelbarrows and

Left—Tramway over which all material was hauled for concreting surge tank, penstock tunnel, piers, and anchor blocks.
Top—Upstream view of the Terrora Development power house with transformer station in the foreground.
Bottom—This picture of work on the Terrora Development was taken from the Lakemont Dam near a portal of the water tunnel.





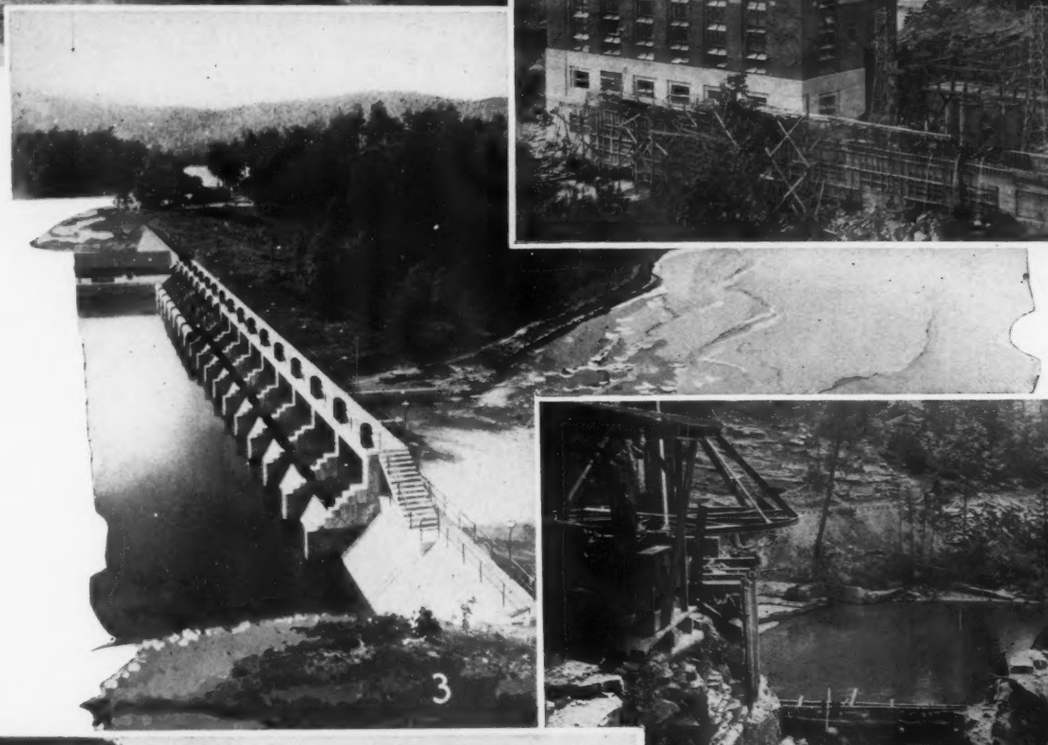


Fig. 1—Terrora power house viewed from the downstream side.
Fig. 2—Upstream view of the power house showing penstock lines, tunnel portal, and surge tank.
Fig. 3—Mathis Dam and Rabun Lake.
Fig. 4—Trench 25 feet deep excavated for Penstock No. 2 at a point adjacent to Terrora power house.
Fig. 5—Intake structure which was substantially completed when this photograph was taken.

An X-70 drill, on a tripod, mounted on a wooden sliding apron. This arrangement was used in excavating a 12-foot trench underneath the transformer station.

wheeled over a plank runway resting on scaffold bars made of 3-inch pipe telescoped inside of 4-inch pipe and supported by iron or steel pins projecting from holes drilled in the side walls. After the 4 cars were loaded they were hand trammed a short distance to a side track and 4 empty cars pushed into place. The loaded cars were hauled from the side track to the dump by mules equipped with specially designed harness—each mule hauling 4 cars per trip. The haulage track was of 16-pound rail gaged to 18 inches.

One of the drill shops equipped with a No. 50 "Leyner" sharpener and a No. 25 Ingersoll-Rand oil furnace.

The mucking crew on each of the regular mucking shifts consisted of the following: 1 muck boss, 6 heading muckers, 3 wheelers, 6 bench muckers, 2 hand trammers, 3 mule skinners, 2 dump men, and 1 water boy. All the spoil, excepting the fly dirt, was handled on slick sheets. The tunnel was of sufficient width to permit 4 laborers to work abreast, while the two other muckers were employed in "picking down."

Four X-70 drifters were employed in the heading attack. These machines were mounted on 4½-inch double-screw columns equipped with 36-inch universal arms. Two X-70's, mounted on a crossbar, were used in bench drilling. The performance of these machines was highly gratifying not only from a standpoint of rapid drilling speed but also on account of low upkeep cost. An average repair cost of 8 cents per cubic yard was obtained. This is a very satisfactory figure when one takes into account the extreme hardness of the rock, the high ratio of feet of drilled hole per cubic yard broken, and the usual rough treatment given a drilling machine in a hard-rock heading. The dependability of these drifters was almost par, as the occasions were very rare indeed when it was necessary to replace a heading machine during a drilling period. The average repair cost per drill shift was 58 cents. A drilling crew consisted of 1 heading boss, 4 drillers, 4 drill helpers, 2 steel nippers, 1 powder monkey, and 1 water boy.

Very satisfactory blasting results were obtained when using Hercules 40 per cent. and 60 per cent. gelatine and California Cap Company's Ideal delay-action exploders. Sixty per cent. gelatine was used in the cut holes, relievers, and lifters, while 40 per cent. gelatine was used in the balance of the round. Explosive records covering the entire tunnel show the following average figures:

Pounds of L. F. gelatin (40% and 60%) used per lin. ft.	39.30
Pounds of L. F. gelatin (40% and 60%) used per cu. yd.	5.40
Number of delay exploders used per lin. ft.	5.64
Number of delay exploders used per cu. yd.	0.78
Pounds of No. 20 connecting wire used per lin. ft. (85 lin. ft.)	0.40
Pounds of No. 20 connecting wire used per cu. yd. (11.8 lin. ft.)	0.056

Very effective ventilation was secured by using No. 5½ Roots low-pressure rotary blowers and 18-inch Bemis Flexipipe.

The penstock tunnel was driven of sufficient cross section — 14 feet high by 27 feet wide—to accommodate 2 penstocks 9 feet in diameter. The rock formation was soft mica schist with horizontal stratification. No trouble was encountered with the side walls, but it was necessary at all times to drive "top spiling" in order to support the roof in advance of the excavation. The method of timbering employed in this soft ground is shown

Hand muckers and mules made an excellent record for themselves on the Terrora Tunnel job. This crew of muckers was posed before the tunnel-heading model which served to show the drillers how to place, space, and drive the holes for a round.

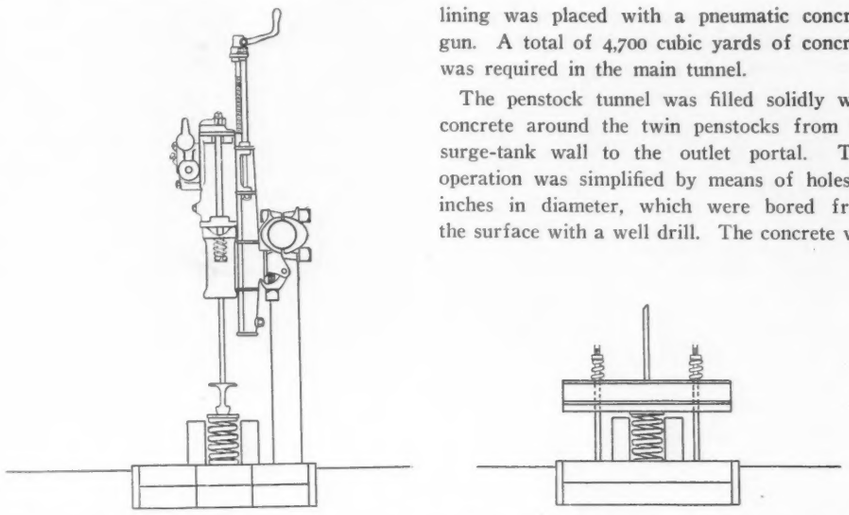
by some of the accompanying illustrations. Where the ground was extremely heavy, a boom set was used instead of the ordinary false set for the purpose of supporting the top spiling.

The surge tank excavation was 40 feet by 20 feet in section and 70 feet deep. The first step in connection with this excavation was an undercut the full width of the tank—40 feet—and 16 feet high at the tunnel horizon. Four post sets of 12x12-inch timber were used to hold this ground. The caps in the center bay, having a span of 15 feet, were further supported by means of 12x12-inch segmental arch sets.

From one of the outer bays, a 6x8-foot raise was driven to the surface with a CC-11 stope-hamer. The full-size excavation lines having been laid off at the surface, hitches were cut and timber trusses, of high safety factor, were placed in exact position on the four sides of the rectangular opening to function as collar bearing sets from which the shaft timber sets were later suspended by hanging bolts.

A hopper and a chute were erected at the bottom of the raise. Excavation attack was carried downward from the surface, and the spoil was drawn from the raise into tunnel cars with a minimum of handling. After each 5-foot cut was excavated, a ring of standard design, made of 8x8-inch shaft timbers, was hung in position, blocked, and lagged. When the connection was made with the tunnel, the several timber sets at tunnel grade, standing within the surge-tank section, were removed.

A steel sharpening plant, equipped with a No. 50 "Leyner" sharpener, a No. 25 I-R oil furnace, and a No. 8 pedestal grinder, was located near each portal. These plants kept both tunnel crews well supplied with drill steels having lug shanks and double-angle crossbits. Considerable thought was given to the layout of the blacksmith shop so as to make it possible to avoid any superfluous handling of drill steels.



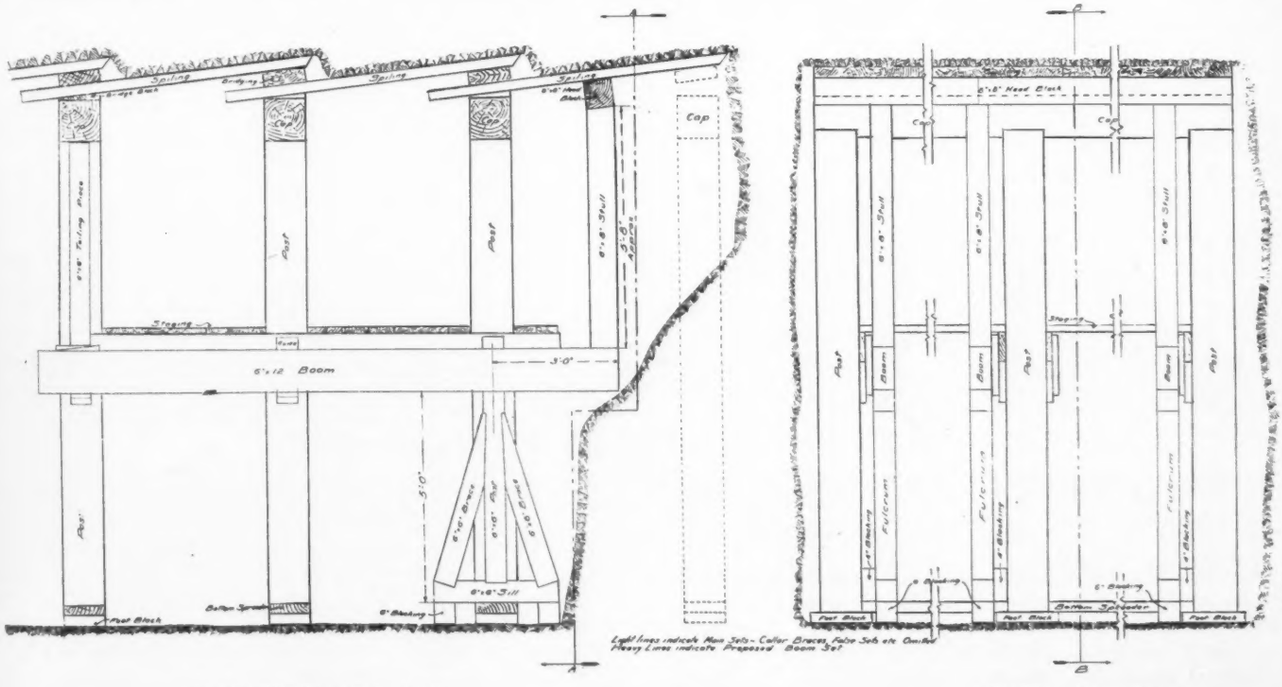
Arrangement of drill-testing box, which served to show whether or not the drills were fit for their work.

The drill-steel records show wear and tear to be as follows: 3.42 pounds per linear foot of tunnel or 0.481 pound per cubic yard. The fuel oil used in the No. 25 oil furnace was of 38° Baumé, and the rate of consumption was: 3.64 gallons per linear foot of tunnel or 0.51 gallon per cubic yard. Owing to the dense character of the rock formation it was necessary to completely line with concrete only 400 linear feet of the main tunnel. The invert was lined the full distance. The concrete placed in the tunnel invert was dumped directly from tunnel cars, but the greater part of the side wall and arch lining was placed with a pneumatic concrete gun. A total of 4,700 cubic yards of concrete was required in the main tunnel.

The penstock tunnel was filled solidly with concrete around the twin penstocks from the surge-tank wall to the outlet portal. This operation was simplified by means of holes, 7 inches in diameter, which were bored from the surface with a well drill. The concrete was poured through these holes, which were spaced 20 feet apart in line with the axis of each penstock and so located as to miss the caps of the tunnel sets. The lagging or spiling was removed at the bottom of each hole to permit free discharge, and the penstocks were protected from abrasion by placing steel sheets directly above them and in line with each hole. All told, 1,500 cubic yards of concrete were poured in this section.

The surge-tank lining consisted of heavily reinforced-concrete—the walls having a minimum thickness of 24 inches. This structure was carried 30 feet above the ground surface and designed with spillway and overflow channel.

Two steel penstocks, 9 feet in diameter and



LONGITUDINAL SECT B-B CROSS SECT A-A

Longitudinal and cross sections of the boom set used in the penstock portion of the tunnel.

approximately 850 feet long, extend from the surge tank to the power house. These penstocks are securely positioned by means of 4 massive, reinforced-concrete anchor blocks, and are further supported by 23 intermediate concrete piers. Four expansion joints in each line insure an adequate provision against expansion and contraction.

The whole of this notable hydro-electric development in northeastern Georgia has been due to the vision and the engineering skill of Mr. Charles G. Adsit, vice-president and executive engineer of the Georgia Railway & Power Company, and his able assistants, Messrs. W. P. Hammond, assistant chief engineer, Horace Pomeroy, manager of construction, and B. W. Sinclair, general construction superintendent.

In conclusion, certain Terrora Tunnel data is presented in the form of a table for the benefit of those that may be interested in such details.

	Lin Ft.	*Cu. Yds.*	*Formation*
Lakemont adit	327	1,086	Hard mica gneiss
Penstock tunnel, including section driven under surge tank	200	3,143	Soft mica schist (timbered)
Main tunnel bore	5,269	38,089	Hard mica gneiss
Totals	5,796	42,318	

Total elapsed time, Lakemont end ..... 10⅓ months
Total elapsed time, Sawtooth end ..... 11⅔ months
Total average monthly progress at both headings ..... 527 lin. ft. or 3,847 cu. yds.
Operating time, two 10-hour shifts daily 6 days per week.

Note: For the purpose of relative comparison, attention is drawn to the fact that the average yardage handled monthly in each heading is the muck equivalent of 811.5 linear feet of 8x8-foot drift. In the main tunnel bore the average progress of 12 linear feet daily—86.4 cubic yards—is equivalent to 36.5 linear feet of 8x8-foot drift in volume of muck handled. All mucking was done by hand, negro labor, and mules were used in tramming.

POWDER, EXPLODER, AND WIRE RECORD

227,660 lbs. of Hercules L. F. gelatin, 40% and 60% @ 16½c	$37,563.80
Pounds used per lin. ft. of tunnel	39.3
Pounds used per cu. yd. of tunnel	5.4
Powder cost per lin. ft. of tunnel	$6.48
Powder cost per cu. yd. of tunnel	0.89
Cost of delay-action exploders per lin. ft. of tunnel	0.80
85 lin. ft. (.4 lb.) No. 20 connecting wire per lin. ft. @ 46c	0.18
Cost of powder, exploders, and connecting wire per lin. ft. of tunnel	7.46

DRILL-STEEL RECORD

Total purchase 1¼-in. round hollow drill steel	40,094 lbs. @	14.8c	$5,953.38
Less inventory, credited to job at half price	20,949 lbs. @	7.4c	1,550.23
Actual amount of steel consumed in tunnel	19,145 lbs.		$4,403.15

Average of pounds of steel used per lin. ft. of excavation	3.42
Average of pounds of steel used per cu. yd. of excavation	0.481
Cost of steel per lin. ft., based on value of total purchase	$1.064
Cost of steel per cu. yd., based on value of total purchase	0.15
Cost of steel per lin. ft., based on value of steel actually consumed	0.488
Cost of steel per cu. yd., based on value of steel actually consumed	0.071

Note: The 19,145 pounds of steel was consumed in excavating—

Main tunnel bore	5,269 lin. ft. or	38,089 cu. yds.
Adit	327 lin. ft. or	1,086 cu. yds.
Adit approach, open cut,		600 cu. yds.
Total excavation	5,596 lin. ft. or	39,775 cu. yds.

DRILL-REPAIR RECORD

Cost of repairs on X-70 drifters per drill shift	$0.59
Cost of repairs on X-70 drifters per cu. yd. of tunnel	0.08
Cost of repairs on X-70 drifters per lin. ft. of tunnel	0.576

FUEL-OIL RECORD

3.64 gals. consumed in blacksmith shop per lin. ft. of tunnel @ 12½c	$0.455
0.51 gal. consumed in blacksmith shop per cu. yd. of tunnel @ 12½c	0.063

GREAT BRITAIN'S NEW POWER PROGRAM

THE new electrical-power program of Great Britain, outlined by the Prime Minister, will be presented to Parliament during the coming session. The bill, if passed, will be of great interest to the country as a whole, and will vitally affect her industries.

The main objects of the bill are the standardization of the frequency, at an estimated cost of £10,000,000; the laying of interconnecting cables between industrial areas; the reduction of the number of generating stations from 584 to 60; and the lowering of rates for electric current.

The sites for the new generating stations will, as far as possible, be on rivers and canals. It is estimated that it will take 15 years to develop the project; and the annual consumption of electricity in the United Kingdom will then be raised to at least 500 kilowatt-hours per capita.

ONE CAUSE OF DECAY IN STONEWORK

RECENT experiments have revealed that well-nigh any water-soluble salt, when allowed to penetrate stone and to crystallize within its pores, causes a wedging action capable of disrupting the strongest materials. The crumbling and the spalling of masonry, exposed to the weather, are usually attributed to the action of frost. However, a similar decay has been found inside of buildings or in warm climates where freezing seldom occurs.

A study of the conditions surrounding several cases of this kind has been made by the United States Bureau of Standards, and has led to the belief that the decay is sometimes caused by the crystallizing of water-soluble matter carried into the stone by water slowly trickling through the pores.

Nearly all kinds of stone, as well as brick, concrete, etc., contain small amounts of soluble matter which can be leached out by water. This matter, if permitted to concentrate at the surface, frequently manifests itself as a growth of white crystals, and is called efflorescence. When crystals of this sort work their way into the materials under consideration they exert a strong wedging action that causes the masonry to crumble and to spall.

OPENING UP COALFIELDS IN KENT

EXTENSIVE plans are underway in England for the development of the coalfields in Kent. It is believed that 2,000,000,000 tons of coal await the miners in Kent, where the so-called East Kent coalfield extends below a large tract of the countryside pivoting upon the historic cathedral city of Canterbury. Two collieries are already working in the district, turning out about 10,000 tons a week. It is proposed ultimately to employ 180,000 men in 18 pits, which, it is estimated, will produce 13,000,000 tons annually.

It is predicted by some authorities that during the next 30 or 40 years the population of the district will be doubled by reason of this new industry. There is also a possibility of the development of iron mining, and of the establishment of blast furnaces.

Dover would be the natural outlet for large vessels serving this area, but Richborough, a port used during the World War, will be used for barge traffic to France and to other Channel ports. The project is being encouraged by the British government, which is guaranteeing a loan of nearly $10,000,000 under the trade-facilities act.

Citroen Cars, Ltd., has recently opened up its new factory at Slough, England. Reports have it that this factory embraces 500,000 square feet of covered workshops, with 60 acres of ground left for expansion. According to Mr. André Citroën, the management hopes to turn out 1,500 cars this year and 30,000 next year. But by 1928 a production of 60,000 cars is to be reached. It is claimed that this is the largest factory in England under one roof. The plant was planned, built, and equipped in the short period of six months. Compressed air will, of course, be used extensively in the various departments in turning out this make of car.

To protect the operators of tram cars from the blinding glare of headlights on approaching automobiles, experiments have been made in Sheffield, England, with colored glass. It has been found that a sheet of blue glass, placed where the motorman can look through it at will, will protect his eyes from the dazzling light. All the tram lines in that city are soon to be provided with these panes of anti-glare glass.

POWER-DRIVEN PUMP DEVISED BY CTESIBIOS

Ctesibios, a famous physicist, born in Alexandria, Egypt, lived about 250 B. C. Ctesibios, the reputed son of a barber, is said to have been the father of Hero, that ancient and distinguished writer on mechanical topics. Our illustration shows the 6-cylinder pump devised by Ctesibios and later described by Hero in his well-known work.

Fig. 1 is a longitudinal section of the pump piston invented by Ctesibios. As can be seen, the hollow of the piston forms an air cushion, and the interior pressure so developed was relied upon to keep the piston tight fitting without recourse to anything like the piston rings of later date. Fig. 2 illustrates an overshot water wheel on the crankshaft working in unison with the undershot water wheel, Fig. 3. The overshot wheel gets the water first, and then the water falls into the trough, Fig. 4, where its momentum acts on the undershot wheel—the paddles on the latter wheel being so spaced that they will receive successively the thrust or momentum of the water issuing from the trough. After leaving the undershot wheel at the point indicated by the numeral 5, the water drops to the last low level from which the pumping system picks up the water. The water passes off at the point indicated by Fig. 6.

Ctesibios is said to have invented a clepsydra, a hydraulic organ, and other mechanical contrivances, and to have first applied the expansive force of air as a motive power.

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EDITORIALS

GOOD ROADS A BIG PROBLEM

ROADBUILDING, and by roadbuilding we include of course the construction of streets in towns and cities, becomes yearly more and more important as an aid to vehicular transportation and, correspondingly, more and more a subject for study on the part of the engineer. The destructive stresses to which roadways are subjected have increased enormously of late.

One has only to look over the lists of abandoned or about to be abandoned trolley systems and branch rail lines in different parts of the United States to realize the amazing extent that the motor bus and the motor truck are supplanting the supposedly established rail haul. What is also very significant is that the newer forms of self-propelled passenger and freight vehicles are engaged in both long- and short-haul services. It is possible today to travel hundreds of miles straightaway in passenger-carrying motor buses. Combined with the many millions of smaller motor cars, it should be self-evident that our streets and highways must be so built that they will stand up under varying and intense stresses, and remain structurally equal to these exactions throughout twelve months of the year—no matter how radical may be the temperature and other weather changes during the period.

Much as has been done already towards standardizing roadbuilding, the art is undoubtedly in a state of flux. This is in part due to the rapidly changing demands that are being made by reason of the augmenting number of automotive vehicles and by the diversified characters of these vehicles and the work they are performing in our economic life. The very fact that motor vehicles are made to promote speed of transportation imposes the use of facilities that will make possible the rapid construction and the rapid repair of the much-used roadways. This has led, of course, to the devising and the producing of mechanical facilities of numerous sorts that enable the roadbuilder to do his work well and expeditiously. The portable compressor and certain air-driven tools are indispensable to the prompt and efficient completion of such construction and repair jobs. These agencies will have much more to do in the future than heretofore; and this will certainly be true before long if some of the pretentious projects under advisement are taken in hand.

There has recently been introduced in Congress a bill calling for the building of 64 highways, having a total length of 53,000 miles, designed to link the National Capital with the State capitals and every important city throughout the length and breadth of the land. The proposed roads would range in width from 18 to 40 feet, and it is estimated that the cost of this undertaking would be about $3,000,000,000. Apart from their peacetime use for vehicular traffic, these hard-surfaced roads would, so it is said, constitute a vital factor in any matured plan of national defense.

AGE OF THE EARTH

THE passing of winter and the ever-recurrent vernal rebirth of vegetal life thrills hundreds of millions of us with the sense of youth; and this perennial occurrence makes many of us wonder why the scientist should still persist in his efforts to establish the age of the earth. What difference would it make to the vast majority of us to learn that this globe of ours has been in existence a hundred million years or even a goodly number of such a period of years—especially when the average human life falls considerably short of the biblical threescore and ten.

However, the man of science has his satisfying reason for pursuing the subject of the earth's antiquity, and he and his brethren are striving in various ways to trace the story back into the distant past by carefully analyzing the physical evidences of rock formations, sedimentary deposits of eons gone, the gradual concentration of the ocean's brine, and the ceaseless but extremely slow processes by which uranium gradually transformed itself by radioactive disintegration into lead of a certain atomic weight.

So many variables enter into the determination of the laying down of sedimentary deposits, and the same is true of other physical upbuildings or denudings of terrestrial areas, that computations based upon observed actions are necessarily unreliable standards by which to gage correctly the formative cycle of sedimentary rock. In the case of the uranium-lead method, on the other hand, the physicist has a primary substance to work with which apparently is entirely unaffected by surrounding influences—at least laboratory research has failed to reveal any weakness or responsiveness in this respect.

By using the uranium-lead method, and analyzing rock formations in which the uranium and the resultant lead are found together, physicists compute the earth—so far as that rock is concerned—to be substantially a billion years old.

COMPETITION IN FOREIGN TRADE GROWS KEENER

DURING a recent Congressional hearing, DR. JULIUS KLEIN, of the United States Department of Commerce, pointed out that our export trade was face to face with a serious crisis, and asked that a sum of more than $3,500,000 be appropriated to enable the Department of Commerce to maintain an aggressive policy in foreign markets in behalf of American producers.

As this expert expressed it: "The outstanding problem in world trade is the coming conflict for foreign markets incident to the economic recovery of our European competitors. Everyone of our overseas rivals has launched a drive against our export markets, and the pressure of these campaigns is already being felt by our exporters in many important trade centers. . . . There can be no doubt about the aggressiveness of that attack; it is a thing to be expected and is not to be criticized. It is perfectly logical. However, we would be foolhardy if we ignored the assaults being made upon the trade that we have been enjoying for a number of years.

"A further factor of our rapidly expanding overseas economic interests, which makes imperative the development of our trade intelligence service, is the growth of American investments abroad, which are now about $9,500,000,000—exclusive of governmental loans—as against slightly over $2,500,000,000 before the war.

"Business should not depend upon the Federal Government to such an extent that it will not be able to walk by itself, but must look to the Government only for information, advice, and guidance."

MYSTERY OF COLD LIGHT NEARER SOLUTION

MAN-MADE light is invariably associated with the generation of heat—the heat rays representing a waste of energy and a corresponding diminution in the intensity of the illumination. Therefore, scientists have sought for years to find out how it is that the firefly, for example, is able to emit its flashes of cold light. The firefly's glow is due to chemical reaction induced at will by that summertime insect; but research has failed to disclose the true nature of the reaction so that man can reproduce the effect for his own purposes and on a scale which will be of service to him.

Recently, a British naturalist has been experimenting with a deep-sea fish that is capable of exuding a slimy secretion which has a weak, bluish glow that persists for sometime after the secretion has been deposited upon any surface. The phosphorescent slime is made up principally of two fatty substances—one of which induces oxidation in the other substance, which is the immediate source of the light. The aim now is to ascertain whether or not the chemist can reproduce these two substances and

apply them to generate cold light on a useful scale.

Cold light could be employed for a great many purposes, and would be especially serviceable in research work involving chemicals and certain delicate forms of life which undergo immediate changes or even perish when illumined by the light now available for the man with the microscope. Many of Nature's secrets might be discovered and things essential to the welfare of humankind might be ascertained if cold light were at the disposal of the investigator.

GERMANS WOULD BUILD CHEAPER CARS

GERMAN automobile manufacturers, according to the *New York Sun*, have set themselves the task of producing cheap cars designed to offset the invasion of American-built automobiles. After much experimenting, and the adoption of partly standardized shop practices, the Germans, so it is reported, are now in a position to build a car of a 7-passenger type that can be sold for $2,500. Cheapness is apparently a relative term, and the German car builder has still a long way to go before he can successfully compete with the many excellent American cars that can be bought at far lower prices.

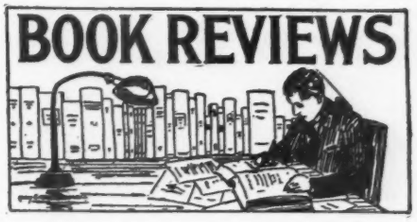
According to *The Sun*, the Germans discovered that it took 2,500 workmen in 1924 to turn out daily not quite 2 cars, whereas now, by the standardized practices adopted, it is possible for 1,000 workmen to produce 6 cars a day.

Months ago this Magazine described how motor cars were assembled in one large American plant which was then producing at the rate of 390 cars a day with a plant personnel numbering 3,500. That performance was in large measure due to the extensive use of compressed air in various ways and to the employment of air-driven tools which enabled the operatives to do just as good work at the end of the working day as they did on entering the shops at the beginning of a shift. The Germans cannot hope to approximate this record until they have recourse to similar facilities utilized with corresponding skill.

At the annual meeting of the board of directors of the American Institute of Mining and Metallurgical Engineers, held in New York City, announcement was made of the acceptance of a fund given by William Lawrence Saunders, President of the United Engineering Societies, for the establishment and support of a gold medal to be conferred each year in recognition of an outstanding achievement in the field of mining. A committee of well-known mining technologists is to formulate the terms of the award.

A sum of $50,000,000 is entered annually on the debit side of the economic ledger of the United States through the disregard of simple rules in wrapping and packing merchandise for domestic shipping.

France embraces a total land area of 212,659 square miles, of which 39,950 are forested.



UP-TO-DATE AIR BRAKE CATECHISM, by Robert H. Blackall and F. H. Parke. A copiously illustrated volume of 707 pages, published by The Norman W. Henley Publishing Company, New York City. Price, $4.00.

THIS is the thirteenth revised edition of this excellent work, and gives a comprehensive treatment of the present state of this important branch of railroad engineering. The air brake, while primarily developed to make it possible to check the speed of a train and to bring it more easily to a standstill, has, strange as it may seem, contributed enormously to speeding up the movements of railway trains. In other words, the air brake has saved time by permitting trains to run farther and faster in a given period while making the required stops.

Few air-brake standards of 25 years ago are in general use today. Locomotives have grown enormously in size and power; longer and heavier trains—both freight and passenger—are the rule now rather than the exception; and new and more powerful brake equipments have been developed or devised to meet successfully the altered service conditions. The book in question is an admirable compendium of this particular department of engineering; and a copy of the work should be in the hands of everyone interested practically or theoretically in the subject.

METHODS AND COSTS OF ROCK-DUSTING BITUMINOUS COAL MINES, by C. W. Owings and C. H. Dodge. An illustrated bulletin of 192 pages, published by the Carnegie Institute of Technology, Pittsburgh, Pa. Price, $1.50.

THE use of rock dust as a means of preventing and limiting coal-dust explosions in bituminous mines has been advocated in the publications of the United States Bureau of Mines during the past fourteen years, but it was not until 1923 and 1924 that mine operators gave serious consideration to the use of rock dust.

The present bulletin is the result of the joint labors of technicists of the Bureau of Mines and the Carnegie Institute of Technology, and is the outcome of extensive research work. The findings as set forth in this bulletin should be of much value to those mines which are prospectives for receiving the treatment, both as to probable cost and method of application; and the pamphlet is issued for the promotion of greater safety in mining.

BOTHERING BUSINESS, by H. A. Toulmin, Jr. A booklet of 57 pages, published by B. C. Forbes Publishing Company, Inc., New York City.

THE Federal Trade Commission has lately been the object of much adverse comment, and more than one critic has urged the abolition of this regulatory body. The author is severely critical of the Commission as it now functions, but he offers, at the same time, constructive suggestions that are deserving of serious consideration. This booklet would undoubtedly interest any person or business enterprise that has been directly or indirectly affected by the activities of the Commission.

PUBLICITY, by Ivy L. Lee. A volume of 64 pages, printed by the Industries Publishing Company, New York City.

PUBLICITY has meant or means many things to the average person, and relatively few of the public influenced by publicity have any clearly defined idea of just what the term embraces. The author has a very definite notion regarding the nature, the purpose, and the scope of so-called publicity; and his long experience in this field of work gives his pronouncement the stamp of authority. Perhaps we can make this clearer by a brief quotation from Mr. Lee's informative book which, by the way, is a collection of addresses made by him.

"I want to tell you something of my conception of publicity and propaganda. In the first place, unlike many people, I do not view publicity as 'press-agentry.' I hear advertising agents occasionally say, . . . 'We will handle the advertising of this situation; we want you to handle the publicity of it.' I always wonder just exactly what they think they mean, because, as I understand publicity, it is the entire gamut of expression of an idea or of an institution, whereas advertising is a mere phase of publicity."

Transactions of the American Institute of Mining and Metallurgical Engineers. The present issue, Vol. LXXI, contains papers and discussions, presented at meetings held during 1924 and 1925, many of which are of outstanding importance. Among the topics dealt with are: *Microscopical constitution of coal; Constitution of coal; Selective combustion in coal; Phosphate deposits of Idaho; Manufacturing problems of cement industry; Brief history of metallurgical practice in canon-making; New developments in high-strength aluminum alloys; Determination of structural composition of alloys; The malleability of nickel; Experiments on the heat treatment of alpha-beta brass; Review of coal-dust investigations; Properties of liquid-oxygen explosives;* etc.

Where to seek for scientific facts is the name of a pamphlet prepared by Alec. B. Eason, M. A. Cantab., and published by S. Rentell & Company, Ltd., London. Price, 1 shilling. The object of this pamphlet is to indicate where people may find

1—Lists of books on various science subjects;

2—Books, or journals and proceedings, transactions and bulletins of learned and scientific societies;

3—Indexes of literature, and publications and papers on technical and scientific subjects;

4—Abstracts of technical papers.

A total of 1,237,658,000 board feet of lumber is used in the United States every year in the construction of packing cases, boxes, and barrels for exporting commodities of one kind or another. This quantity is equal to 3⅓ per cent. of the annual cut.

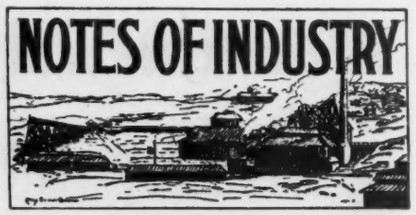
Passengers and cargoes are now carried across the oceans between the continents almost wholly by steamships of 5,000 gross tons or over. There were 4,250 of these vessels, aggregating 30,150,000 gross tons, in this oversea service, in June, 1925, according to Lloyds' Register.

In 1925, Bolivia supplied 28 per cent. of the world's total output of tin.

Arrangements have been made by the Imperial Airways, Ltd., for an experimental nighttime freight service by airplane between London and Paris. The machine to be employed is of the Vickers-Rolls Royce express type, the largest of its kind in the world. If the tests are successful, the service will be made a regular feature, and will probably be followed by a night service for passengers.

The value of the output of the famous Hollinger gold mine, in the Province of Ontario, Canada, passed the $100,000,000 mark in January of this year.

Japan's foreign trade for 1925 was the largest in the history of that country.



Contracts for 5,034 new refrigerator cars, costing approximately $16,000,000, have been awarded by one of the big national fruit express companies. This represents one of the largest orders of its kind in the history of railroading in the United States.

In 1925, a total of 14,000,000 pounds of dynamite were set off in quarries in the United States supplying raw material to the domestic cement industry.

With 878 kilowatt-hours available per capita, Canada now leads in the generation of electric power. Switzerland is next in line, with 505 kilowatt-hours for each inhabitant, and the United States comes third with 484 kilowatt hours per capita. Based on the total capacity of her electric-power plants, which amounts to 8,099,192,000 kilowatt-hours, the Dominion holds second place among the nations of the world in the production of electricity.

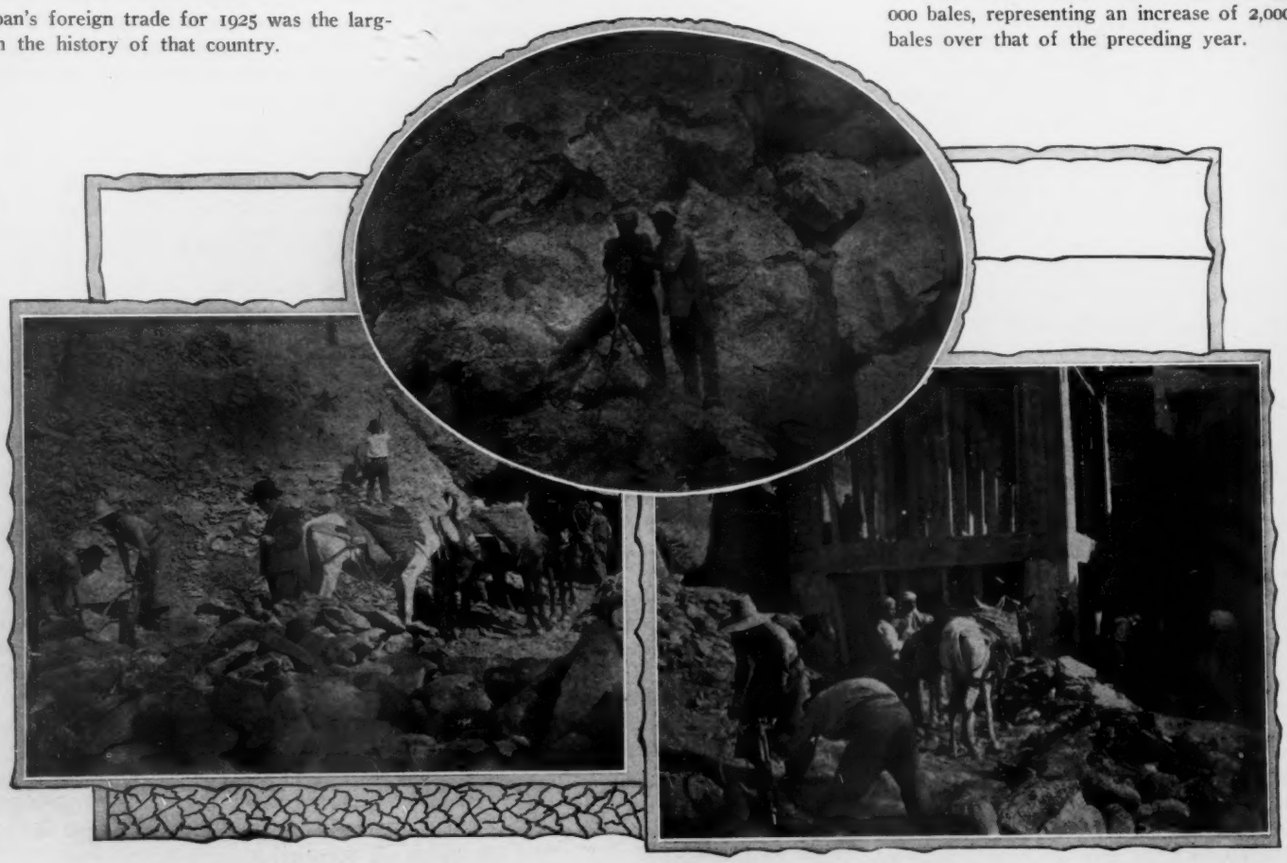
Just 20 years ago, early in 1906, the first train passed through the then completed Simplon Tunnel, in Switzerland, which will always remain one of the world's notable achievements. The tunnel was opened to traffic 50 years after it was first suggested and 8 years after work on it was started. As the problems involved in its construction were new at the time and as much of the machinery employed had to be invented for the job, the project has since served as an engineering milestone to tunnel builders.

A Federal road planned for Hawaii National Park will extend to the top of Mount Haleakala, making it possible for automobile tourists to attain an altitude of 10,000 feet above sea level and to view at close range one of the world's largest extinct craters.

The Pennsylvania Railroad is now operating 139 all-steel dining cars, having a seating capacity exceeding 5,000 persons. To make the cars as fireproof as possible, aluminum chairs are to be used throughout.

A total of 17,000 miles of cotton cloth, 30 inches wide, is needed annually to supply new sacks for the cement manufactured in the United States.

According to official estimates, the 1925 cotton crop of the United States exceeded 15,500,000 bales, representing an increase of 2,000,000 bales over that of the preceding year.



In excavating for the foundation of the Oriental Hotel at Algiers, in Algeria, it has been necessary to remove a great deal of rock. Here we see paving breakers and "Jackhamers" at work on the job, while African donkeys are utilized to remove the broken rock. Thus products of the new and the old world are doing their bit in providing Algiers with a thoroughly up-to-date hotel.